NATIONAL SCIENCE FOUNDATION

FY 2007 Budget Request to Congress

February 6, 2006

On the cover: ***Exponentia.*** In addition to his work as professor of physics and chemistry at Harvard University and National Science Foundation (NSF) grantee, Eric Heller creates digital abstract art inspired by an unseen world—the quantum realm of electrons, atoms, and molecules. Inspired by the experiments of Mark Topinka, Brian Leroy, and Robert Westervelt at Harvard University, Heller created this image based on electron flow paths in a two-dimensional electron gas (2DEG).

To create *Exponential,* Heller first generated a file containing a computer simulation of the physical phenomenon and then used several different computer algorithms to simulate that phenomenon. He traced over 100,000 individual electron paths, starting at the top right, where they were launched on their journey, each with a slightly different direction. White regions in the image show the paths preferred by the electrons. The concentrations of electron flow are unexpected indirect effects of the bumpy ride. The channeling or branching was a surprise to the researchers and may provide new insights for future nanotechnology research.

Heller often collaborates with Westervelt, a professor in the Department of Physics and the Division of Engineering and Applied Physics at Harvard and principal investigator of an NSF grant to develop a Nanoscale Science and Engineering Center at Harvard. For more information, visit http://monsoon.harvard.edu and click on "Art."

Cover image courtesy of Eric Heller, Harvard University

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FY 2007 BUDGET REQUEST TO CONGRESS

Budget Request

The National Science Foundation proposes a FY 2007 investment of $6.02 billion to advance the frontiers of research and education in science and engineering. The Budget Request includes an increase of $439 million, or 7.9 percent, over FY 2006. At this level, NSF can boost the momentum of discovery in areas of exceptional promise and move aggressively to capitalize on emerging opportunities.

In pursuing the Administration's research priorities within the larger federal research and development effort, NSF's unique task is to tenaciously search out the frontier – to foster the fundamental research that delivers new knowledge to meet vital national needs and to improve the quality of life for all Americans. Our nation's future depends more and more on the quality of our new ideas, the vitality of our science and engineering workforce, and the innovative use of new knowledge generated through our research and education enterprise. As part of the President's American Competitiveness Initiative, the FY 2007 Budget Request reflects the Administration's firm commitment to doubling the NSF budget over ten-years in order to sustain a robust, competitive, and productive America.

The NSF portfolio for FY 2007 emphasizes four priorities that will strengthen the science and engineering enterprise through investments in frontier research, the workforce, education, and cutting-edge research tools:

- Advancing the Frontier.
- Broadening Participation in the Science and Engineering Enterprise.
- Providing World-Class Facilities and Infrastructure.
- Bolstering K-12 Education.

NSF Funding by Account

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Research and Related Activities	$4,234.82	$4,331.48	$4,665.95	$334.47	7.7%
Education and Human Resources	843.54	796.69	816.22	19.53	2.5%
Major Research Equipment and Facilities Construction	165.14	190.88	240.45	49.57	26.0%
Salaries and Expenses	223.45	246.81	281.82	35.01	14.2%
National Science Board	3.65	3.95	3.91	-0.04	-1.0%
Office of Inspector General	10.17	11.36	11.86	0.50	4.4%
Total, NSF	$5,480.78	$5,581.17	$6,020.21	$439.04	7.9%

Totals may not add due to rounding.

Total funding for FY 2006 MREFC also includes an unobligated balance of $14.88 million carried over from FY 2005, distributed pro rata to the ALMA, EarthScope, IceCube and SODV projects. Including this amount, the MREFC account total is $205.76 million in FY 2006.

Why Frontier Research Matters

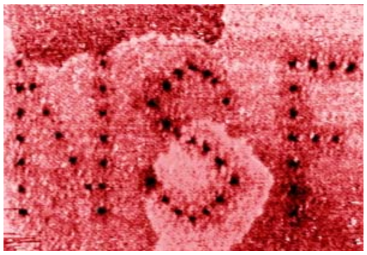
The fruits of research and education in science, engineering, and technology have steadily lifted America's standard of living. In every sector, every community and every region, discovery, learning and innovation are the dynamos driving wealth-producing growth and job creation. Americans rely on new knowledge and cutting-edge technologies to make their lives better. And every American depends on the excellence of U.S. schools and universities to provide students with the skills they require to flourish and to make their own contributions to America's economic future and social well being.

America has always measured her progress not through comparisons with traditional standards, but by setting new standards - pursuing unmet challenges and venturing into unexplored territory. Today, however, this is becoming increasingly difficult, with the prospect of nations like China and India building powerful economic momentum through a burgeoning science and engineering workforce and strong research capacity. There is intense competition for ideas and talent, for comparative advantage and market opportunities worldwide. Robust investments in science and engineering research and education are now more fundamentally critical than ever before to meeting the Nation's challenges: combating terrorism at home and abroad, feeding the fires of industrial innovation, educating world-class knowledge workers, and addressing health and the environment.

Research that Benefits the Nation

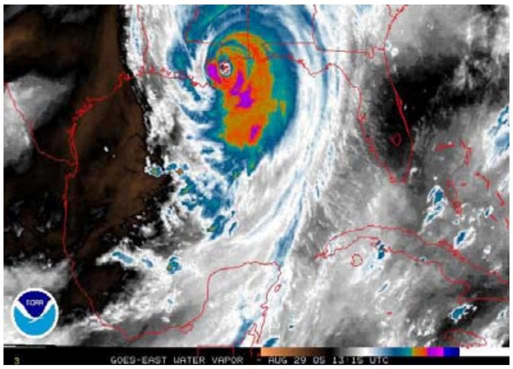
As the pace of discovery and innovation quickens, the lag between frontier research and its application is shrinking, bringing the benefits of frontier research to Americans at lightening speed. Just this past year, researchers funded by NSF reported significant results and launched new research initiatives that will keep those benefits flowing. The following research exemplifies this progress.

► By applying electric current through a thin film of oil molecules, mechanical engineer Arjay Malshe of the University of Arkansas and his students have developed a new method to precisely carve arrays of tiny holes only 10 nanometers wide into sheets of gold. The process may yield miniscule molecular detection devices, semiconducting connectors, molecular sieves for protein sorting and nanojets for fuel or drug delivery. The research is part of the National Nanotechnology Initiative, led by NSF.



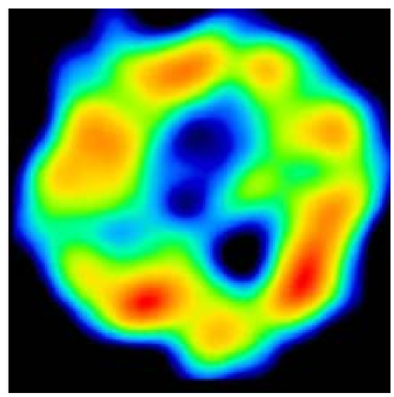
► As part of NSF's Cyber Trust program, Bill Sanders at the University of Illinois and colleagues at four universities are addressing the challenge of designing, building, and validating a secure cyberinfrastructure for the next-generation electric power grid. The project will create technologies that will convey critical information to grid operators despite cyber attacks and accidental failures. The investigators expect that the solutions created will be adaptable for use in other critical infrastructure systems. The research will also help meet a major homeland security challenge.

► Researchers with the International Rice Genome Sequencing Project (IRGSP) have completed the DNA blueprint for a crop that feeds over half the people in the world. Rice is the first crop plant whose genome has been sequenced. Scientists around the world will use the wealth of new information in efforts to improve yields in not only rice, but also in other closely related grass crops such as barley, corn, rye, sugarcane, and wheat. Formally established in 1998, the IRGSP consortium includes Japan, the United States, China, Taiwan, Korea, India, Thailand, France, Brazil, and the United Kingdom.

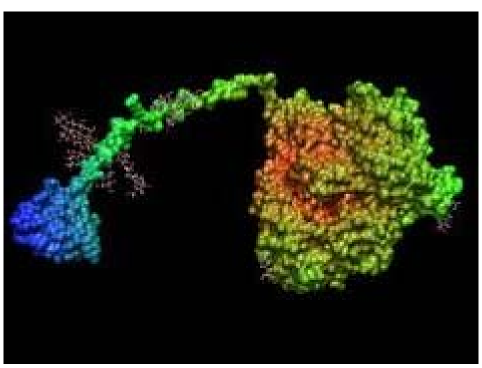


► Real-time radar data and high-tech communications were the keystones to success recently as the Rainband and Intensity Change Experiment (RAINEX) project began its research with Hurricane Katrina. The first hurricane research project to fly planes nearly simultaneously inside and outside a hurricane's principal rainband, RAINEX gathered information that will help scientists to better understand changes in a hurricane's intensity, and to validate state-of-the-art numerical models used in forecasting. Once data are collected and analyzed, the researchers will share this information with hurricane operational centers and national environmental prediction centers throughout the country and the world.

► Scientists funded by NSF and the European Commission have announced the CRONUS project: a new initiative that will use cosmic rays from the distant heavens to reconstruct the history of geologic events here on Earth. The cosmic rays come from galactic explosions known as supernovas, which send billions of the fantastically energetic atomic particles slamming into the Earth's surface every year. These impacts, in turn, blast apart atoms in the rocks to create new elements, which accumulate over time. So by measuring those atoms, scientists can gauge how much time has passed since the rock was disturbed by geological events such as earthquakes, landslides, and glaciers. The new cosmic-ray methods will shed light on Earth's past climate cycles, changes in soil erosion, frequency of floods and landslides, and how weathering of rocks affects global warming and cooling.



► To develop efficient large scale conversion of biomass into ethanol to provide a clean-burning and renewable fuel source, researchers at the National Renewable Energy Laboratory simulated the action of the enzyme cellulase on cellulose using the CHARMM (Chemistry at HARvard Molecular Mechanics) code, a versatile community code for simulating biological reactions. The binding domain is in blue, the glycosylated linker in green, and the catalyst domain in orange and yellow. San Diego Supercomputer Center researchers are working to enhance CHARMM to perform the largest simulation ever of a scientific problem that will yield economic and environmental benefits.



Investment Priorities

Advancing the Frontier

NSF's unique task is to generate ideas, mark out the creative path, or solve a fundamental research question. Our commitment to excellence in research and education leads us to engage the scientific and engineering communities to identify the most promising directions and the best researchers. NSF proposes to increase investments in Research and Related Activities by $334 million, or 7.7 percent, in FY 2007.

- **NSTC Priorities.** Activities coordinated by the National Science and Technology Council (NSTC) receive increased support: Networking and Information Technology Research and Development (NITRD) at $904 million (up $93 million); the National Nanotechnology Initiative (NNI) at $373 million (up $29 million); and the Climate Change Science Program (CCSP) at $205 million (up $8 million); Homeland Security activities also increase by $42 million, to $384 million. Highlights of FY 2007 activities include:
    - **Cyber Trust and Cybersecurity.** The NITRD investment includes $35 million (an increase of $10 million) for Cyber Trust, a cutting-edge research program to ensure that computers and networks underlying national infrastructures, as well as in homes and offices, can be relied on to work, even in the face of cyber attacks. Cyber Trust is part of a larger NSF Cybersecurity and Information Assurance research effort totaling $97 million, an increase of 26 percent in FY 2007.
    - **Nanoscale Interdisciplinary Research Teams (NIRT).** The NNI investment includes $65 million for Nanoscale Interdisciplinary Research Teams. These awards encourage team approaches to address nanoscale research and education themes where a synergistic blend of expertise is needed to make significant contributions.

National Science and Technology Council Crosscuts
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006	
				Amount	Percent
National Nanotechnology Initiative	$334.99	$343.77	$373.18	$29.41	8.6%
Climate Change Science Program	197.88	196.88	205.25	8.37	4.3%
Networking and Information Technology R&D	810.67	810.33	903.74	93.41	11.5%
Homeland Security	341.40	341.82	384.21	42.39	12.4%

- **Sensors for the Detection of Explosives.** NSF will invest $20 million in fundamental research on new technologies for sensors and sensor systems to improve the detection of explosives, including Improvised Explosive Devices (IEDs). Related research will target advances in the analysis, interpretation, and evaluation of data gathered from sensors, as well as the integration of this data with information available from a wide variety of other fields and sensing systems. This NSF investment is part of a broader, coordinated interagency effort.

- **International Polar Year.** NSF is the lead agency for U.S. activities recognizing the International Polar Year (IPY), which spans 2007 and 2008. NSF proposes a first-year investment of $62 million to address major challenges in polar research. Key programs include: Study of Environmental Arctic Change; Polar Ice Sheet Dynamics and Stability; and Life in the Cold and Dark. The investment will also support associated logistics, infrastructure, and education and outreach activities.

- **Elementary Particle Physics.** NSF will expand its investment in elementary particle physics by $15 million to exploit opportunities for discovery that physicists describe as greater than at any point in the last half-century. Recent advances strongly suggest that we are on the verge of a revolution in our understanding of the nature of matter, energy, space, and time. The investment is coordinated with activities in the interagency plans for research on the Physics of the Universe.

- **Science Metrics.** A new research effort to address policy-relevant Science Metrics is funded initially at $6.8 million. The goal is to develop the data, tools, and knowledge needed to establish the foundations for an evidence-based "science of science policy." NSF intends to pursue this research in close cooperation with other agencies.

Broadening Participation in the Science and Engineering Enterprise

In FY 2007, NSF will continue to emphasize programs aimed at tapping the potential of those underrepresented in the science and engineering workforce – especially minorities, women, and persons with disabilities – and on ensuring that the U.S. enjoys a strong capability in science and engineering across all regions of the country. These investments will total over $640 million in FY 2007.

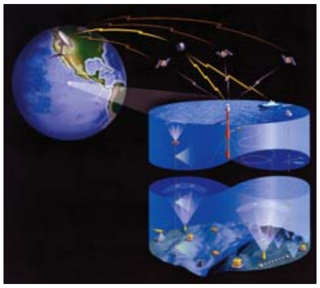
- **Principal Investments.** Three highly successful programs form the core of this investment: the Louis Stokes Alliances for Minority Participation, the Alliances for Graduate Education and the Professoriate, and the Centers of Research Excellence in Science and Technology. These programs increase by $16.15 million or 24 percent in FY 2007.

- **EPSCoR.** Funding for the Experimental Program to Stimulate Competitive Research (EPSCoR) will rise to nearly $100 million, a $1.28 million increase over FY 2006.

Providing World-Class Facilities and Infrastructure

The science and engineering enterprise depends increasingly on sophisticated tools to advance the frontiers of knowledge. NSF has a long-established role in providing broadly accessible, state-of-the-art infrastructure to meet major research challenges. NSF's strategy is to invest in tools that promise significant advances in a field of research and to make them widely available to a broad cross-section of investigators.

- **MREFC.** Total funding in the Major Research Equipment and Facilities Construction (MRFEC) account is $240.45 million, an increase of $49.57 million or 26 percent in FY 2007. The FY 2007 request includes two new starts: the Alaska Region Research Vessel (ARRV) and the Ocean Observatories Initiative (OOI). Both projects will help to fulfill the Administration's 2004 U.S. Ocean Action Plan, developed in response to the U.S. Commission on Ocean Policy.



- **Cyberinfrastructure.** Cyberinfrastructure is likely to be a key factor determining research excellence for many years to come. NSF will increase funding for cyberinfrastructure research and development by $77 million to $597 million, an increase of 15 percent. NSF proposes to invest $50 million to begin the acquisition of a leadership-class high performance computing (HPC) system, optimally configured to enable an orderly progression toward petascale level science and engineering computation and data processing. This investment is critical to NSF's multi-year plan to provide and support a world-class computing environment that will make the most powerful HPC assets broadly available to the science and engineering community.

Bolstering K-12 Education

NSF has a long history of building strong research foundations and fostering innovation in K-12 science and mathematics education. Skills in science, technology, engineering and mathematics are increasingly necessary for success in the workforce and for full participation in the life of the Nation.

- **Discovery Research K-12.** In FY 2007, NSF will invest $104 million in the Discovery Research K-12 (DRK-12) program to strengthen K-12 science, technology, engineering, and mathematics education. The program will support targeted research to advance understanding in three well-defined grand challenges in K-12 education: developing effective science and mathematics assessments for K-12; improving science teaching and learning in the elementary grades; and introducing cutting-edge discoveries into K-12 classrooms.

- **Math and Science Partnership.** The request includes total funding of $46 million, a decrease of $17 million, for the Math and Science Partnership (MSP) program. This investment continues support for five Teacher Institutes for the 21st Century to be awarded in FY 2006, designed to develop school-based intellectual leaders, and brings the total number of Teacher Institutes to 13.

- **GK-12.** Funding for the Graduate Teaching Fellowships in K-12 Education (GK-12) program increases by 9.9 percent to $55.66 million, supporting an estimated 1000 graduate fellows. This program encourages effective partnerships between institutions of higher education and local school districts through a program of outreach that pairs graduate students and K-12 teachers in the classroom.
- **Middle and High School Geosciences Education.** A total of $3.0 million will fund a new program to improve geosciences education at the middle and high school levels.

Delivering Results

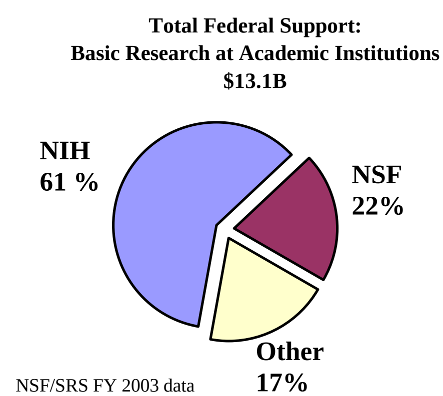
The Nation's economic productivity is enhanced when federal agencies work smarter, producing desired outcomes at acceptable costs. The nature of NSF's programming gives the agency an invaluable level of flexibility and agility. Since only 6 percent of the agency's budget is spent on internal operations – with the remaining 94 percent supporting outside entities working at the frontiers of learning and discovery – NSF has proven time and again that it can respond decisively and proactively to emerging opportunities and challenges.

For NSF and other federal agencies with significant R&D portfolios, assessment activities are required to draw heavily upon the R&D Investment Criteria. NSF's FY 2007 Budget Request incorporates the Research and Development Investment Criteria established by OMB and the Office of Science and Technology Policy and outlined in the President's Management Agenda. These three criteria, Relevance, Quality, and Performance, are described below and are reflected in each of the directorate and office narratives throughout this Budget Request.

Relevance: R&D programs must be able to articulate *why* this investment is important, relevant, and appropriate.

NSF is the only federal agency with a mandate to strengthen the health and vitality of U.S. science and engineering and support fundamental research and education in all scientific and engineering disciplines. NSF-sponsored activities result in new across-the-board knowledge and technologies and educate a world-class workforce of scientists, engineers, mathematicians, educators, and other technically trained professionals.

Although NSF investments account for only 4 percent of total federal funding for research and development, the agency provides 22 percent of federal support to academic institutions for basic research. NSF investments are especially vital in non-medical fields and disciplines. For over two decades, NSF has been a principal source of federal support for basic research at colleges and universities in such areas as computer science, mathematics, the physical sciences, the social sciences, the environmental sciences, engineering, and non-medical areas of the life sciences. Furthermore, while NSF does not directly support medical research, its investments



benefit the medical sciences and related industries, leading to advances in diagnosis, regenerative medicine, drug delivery, and the design and manufacturing of pharmaceuticals.

The NSF Strategic Plan for FY 2003-2008 is set in the context of the evolving long-term issues that are transforming science and education research. Researchers operate in an increasingly complex environment, in which science and engineering cross the boundaries of disciplines, organizations, and nations. The frontier changes quickly, and discovery requires ever-more-sophisticated skills and methods, as well as technology and instrumentation. Global competition for technical workers and science and education professionals has intensified, and so have the skills expected in today's changing workplace. Leadership and excellence in discovery, innovation, and learning are the most effective means to meet and surpass these new challenges.

Quality: R&D programs must justify *how* funds will be allocated to ensure quality R&D.

Competitive merit review is the recognized "gold standard" in selecting the highest quality research proposals. NSF has a long history of merit review; nearly 90 percent of the agency's research and education funding goes to awards selected through a competitive merit review process.

All proposals for research and education projects are evaluated using two criteria: the *intellectual merit* of the proposed activity and its *broader impacts*, ranging from effects on teaching, training, and learning to improvements in cybersecurity. Reviewers also consider how well the proposed activity fosters the integration of research and education and broadens opportunities to include a diversity of participants, particularly from underrepresented groups.

In FY 2005, NSF awarded nearly 10,000 new grants from about 41,700 competitive proposals, a funding rate of 23 percent. Perhaps the most dramatic indicator of the level of competition for NSF funding is the quality of the proposals that go unfunded every year. In FY 2005, for example, proposals totaling $1.9 billion were declined even though they were rated as highly as the proposals that received funding. These declined proposals represent a rich portfolio of highly regarded yet unfunded opportunities to advance research and education.

Further, to ensure the highest quality in processing and recommending proposals for awards, NSF 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. In addition, NSF directorates also use external Advisory Committees to offer recommendations on such issues as: the mission, programs, and goals that can best serve the scientific community; how to promote quality graduate and undergraduate education; and priority investment areas for NSF-funded research.

Performance: R&D programs must be able to monitor and document *how well* the investment is performing.

Performance assessments are intended to evaluate whether the agency's investments achieve the long-term goals outlined in the NSF FY 2003-2008 Strategic Plan. Specific measures of organizational effectiveness relate to the internal practices, operations, and processes that support the NSF mission. Historically, NSF has relied upon external committees of experts to evaluate the long-term outcomes from research and education. This is appropriate given the broad scope of science and engineering covered by

NSF, and the critical and extensive use of merit review for selecting new awards. Today, these external evaluations provide integral information for the assessments conducted using the Program Assessment Rating Tool (PART).

The NSF Advisory Committee for GPRA Performance Assessment (AC/GPA) leads the annual evaluation of NSF's performance. In FY 2005, the AC/GPA determined that the agency demonstrated significant achievement in meeting its four long-term goals of Ideas, Tools, People, and Organizational Excellence. In its report, the Committee recognized the strength of the agency's portfolio is as a whole rather than in each of the goals separately:

> "The Committee also concluded that the four outcome goals are mutually reinforcing and synergistic. They represent an integrated framework that combines research and education in a positive way and also provides the organizational infrastructure to advance the national scientific, technological, engineering, and mathematics enterprise. Thus, all four goals should always be considered as an integrated whole when assessing NSF's performance."

Another assessment method of NSF's activities is conducted through the government-wide Program Assessment Rating Tool, or PART. The PART process has developed into a central component of NSF's performance framework. Thirteen "Investment Categories" were developed for PART review. These categories are aligned with the long-term goals established in the Strategic Plan. To date, ten of the thirteen investment categories have undergone PART review. All ten have received the highest rating of "Effective". The remaining three investment categories will be assessed during 2006 and reported in next year's Budget Request. Descriptions of the strategic goals and their associated investment categories are presented below. Further information, including the PART schedule, is included in the Performance Chapter.

Investment Strategy

NSF invests in a rich mix of programs, platforms, and partnerships developed by the research and education community. Funding levels for these programs and activities in the FY 2007 request directly link with the Strategic Outcome Goals and Investment Categories established in the NSF Strategic Plan for FY 2003-2008.

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

In FY 2007, NSF is requesting $2.92 billion, an increase of $166.71 million, or 6.1 percent, over the FY 2006 Current Plan, to support the best ideas generated by the science and engineering community. Through its three investment categories, the Ideas goal promotes research activities in highly promising areas, both disciplinary and interdisciplinary.

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

		FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Ideas	Fundamental Science and Engineering	$2,283.43	$2,270.88	$2,413.72	$142.84	6.3%
	Centers Programs	236.67	253.25	259.78	6.53	2.6%
	Capability Enhancement	218.98	224.18	241.52	17.34	7.7%
		2,739.08	2,748.31	2,915.02	166.71	6.1%
Tools	Facilities	475.13	514.32	580.30	65.98	12.8%
	Infrastructure and Instrumentation	464.04	479.40	565.30	85.90	17.9%
	Polar Tools, Facilities and Logistics	278.16	306.95	345.56	38.61	12.6%
	Federally-Funded R&D Centers	182.10	187.45	194.08	6.63	3.5%
		1,399.44	1,488.12	1,685.24	197.12	13.2%
People	Individuals	522.22	496.36	519.84	23.48	4.7%
	Institutions	145.28	146.92	146.54	-0.38	-0.3%
	Collaborations	394.69	388.37	404.04	15.67	4.0%
		1,062.19	1,031.65	1,070.42	38.77	3.8%
Organizational Excellence		280.07	313.09	349.53	36.44	11.6%
Total, NSF		$5,480.78	$5,581.17	$6,020.21	$439.04	7.9%

Totals may not add due to rounding.

Fundamental Science and Engineering. In FY 2007, investments total $2.41 billion, an increase of $142.84 million, over the FY 2006 Current Plan. Advancing the frontier in all science and engineering fields is a priority for FY 2007 and will be accomplished through balanced investments across NSF programs. Research under this investment category spans the entire range of disciplines supported by the agency. Specific highlights can be found in each of the individual directorates' or offices' chapters.

Interdisciplinary research is also a key focus of this investment category, including National priorities such as nanotechnology, networking and information technology, climate change, plant genome research, and homeland security. A PART review of the Fundamental Science and Engineering investment category was completed for this Budget Request. The assessment found this set of programs to be "Effective."

Centers Programs. Center investments enable organizations to integrate ideas, tools, and people on scales that are large enough to significantly impact important S&E fields and cross-disciplinary areas. Therefore, Centers play a key role in advancing science and engineering in the U.S., particularly through their encouragement of interdisciplinary research and the integration of research and education. Investments in FY 2007 total $259.78 million, an increase of $6.53 million over the FY 2006 Current Plan. NSF plans to initiate four additional Science and Technology Centers (STC) in FY 2006 as well as continue support for two Centers initiated in FY 2005. Funding for all ongoing STCs totals $67.48 million. Support for Science of Learning Centers (SLC) increases by $4.29 million to a total of $27.0 million. In FY 2007, NSF continues the fourth of five initial years of support for four SLCs awarded in the program's first competition. The increased funding will sustain existing SLC investments, supporting multidisciplinary research that advances fundamental knowledge about the science of learning. A PART review of this investment category will be completed for next year's Budget Request.

Capability Enhancement. In FY 2007, investments totaling $241.52 million, an increase of $17.34 million, will build the capability of individuals and institutions to perform high quality, competitive research, education, and technological innovation. A 39 percent increase in Centers of Research Excellence in Science and Technology (CREST), up $7.04 million to $24.94 million, will strengthen research and education in minority-serving institutions. Funding is also increased for EPSCoR, up $1.28 million to $100 million, and Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR), up $8.52 million to $108.88 million. A PART review of this investment category will be completed for next year's Budget Request.

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

In FY 2007, NSF proposes to invest $1.69 billion, an increase of $197.12 million, in the development and stewardship of a wide variety of facilities, instrumentation and other infrastructure. Leading-edge tools are essential to researchers working at the frontier of science and engineering, and to students who will bring skill in their use into the workplace. NSF is placing a high priority on investments in the development of cyberinfrastructure and in unique national facilities.

Facilities. NSF proposes investments in FY 2007 totaling $580.30 million, an increase of $65.98 million, in the development, construction, and operation of state-of-the-art facilities and platforms that enable researchers and educators to work at the frontier of discovery. The $240.45 million request for the Major Research Equipment and Facilities Construction account, a part of NSF's overall Facilities investment, will support projects of national importance. These include the Atacama Large Millimeter Array (ALMA) ($47.89 million), EarthScope ($27.40 million), IceCube ($28.65 million), the National Ecological Observatory Network ($12.0 million), and the Scientific Ocean Drilling Vessel ($42.88 million). Two new starts are requested in FY 2007. In priority order, they are the Alaska Region Research Vessel ($56.0 million) and the Ocean Observatories Initiative ($13.50 million). A PART review of the Facilities investment category was completed for the FY 2005 Budget Request. The assessment found this set of programs to be "Effective."

Infrastructure and Instrumentation. FY 2007 investments totaling $565.30 million, an increase of $85.90 million, support state-of-the-art instruments, platforms, information technology, databases, and other tools to advance U.S. leadership in science and education, and increase productivity and innovation among researchers, educators, and students working at the frontier. This also includes $90.0 million to support the Major Research Instrumentation program (MRI). Investments in MRI support a wide variety of mid-sized state-of-the-art research equipment, and reach a broad range of institutions, including non-Ph.D-granting colleges, universities and community colleges. NSF also requests $50.0 million to begin the acquisition of a leadership-class, high performance computing (HPC) system optimally configured to enable petascale science and engineering. This interagency HPC partnership allows participating agencies to leverage expertise and promising practices, minimizes duplication of effort and ultimately promises to increase the architectural diversity of leadership class systems available to researchers and educators around the country. A PART review of the Infrastructure and Instrumentation investment category will be completed for next year's Budget Request.

Polar Tools, Facilities and Logistics. Investments totaling $345.56 million, an increase of $38.61 million, will provide state-of-the-art tools, facilities, and other infrastructure to advance polar research and education. NSF requests $61.57 million for research and education activities related to the International Polar Year. Activities include Arctic environmental change, polar ice sheet dynamics and stability, and life in the cold and dark. As in FY 2006, NSF has the responsibility for funding the costs of icebreakers that support scientific research in polar regions. NSF will work with OSTP, OMB, and the U.S. Coast Guard to determine the appropriate funding request for this activity in FY 2007, but as a placeholder NSF proposes to fund this activity at a reduced level (-3 percent) in FY 2007. In addition, funding is requested through the MREFC account to complete construction of the South Pole Station ($9.13 million). A PART review of the Polar Tools investment category was completed for last year's Budget Request. The assessment found this set of programs to be "Effective."

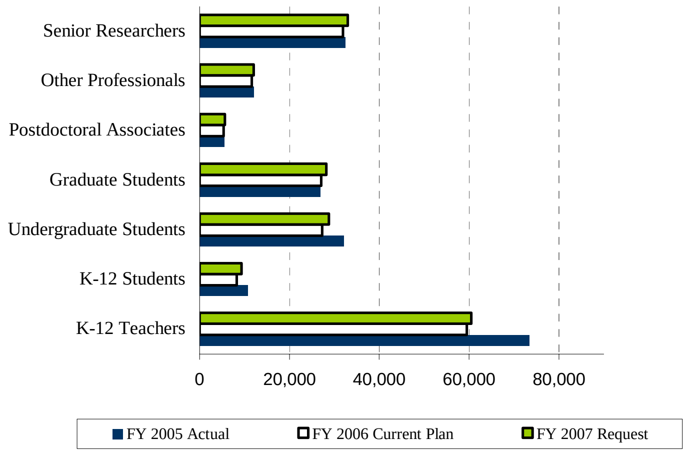
Federally-Funded Research and Development Centers. FY 2007 investments in FFRDCs total $194.08 million, up $6.63 million over FY 2006. FFRDCs address research, development, and policy issues that create unique, important, and long-term capabilities for the federal government, in response to law, mandate, or widely recognized need. Funding of $86.85 million, an increase of $3.49 million, for the National Center for Atmospheric Research will support continued activities at the Center and provide roughly $5.0 million to operate the HIAPER (High-Performance Instrumented Airborne Platform for Environmental Research) research aircraft. Funding for the National Optical Astronomy Observatory (NOAO) increases by $3.14 million to enhance community-based instrumentation activities (the Adaptive Optics Development Program and the Telescope System Instrumentation Program) that NOAO manages; total funding for NOAO is $40.05 million. A PART review of the FFRDC investment category was completed for this Budget Request. The assessment found this set of programs to be "Effective."

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

The Foundation's FY 2007 budget provides $1.07 billion, an increase of $38.77 million, or 3.8 percent, above the FY 2006 Current Plan, to prepare a highly skilled and diverse science and engineering workforce. Within this total, programs that have been successful in broadening participation among groups, communities, regions, and institutions that are underrepresented in science and engineering fields will been increased.

Individuals. Investments totaling $519.84 million, an increase of $23.48 million, support the education and training of world-class scientists, engineers, mathematicians, technologists and educators. Among programs targeted for sustained or increased investment are Noyce Scholarships, up $1.0 million to a total of $9.77 million and Scholarship for Service/Cybercorp, up $500,000 to $10.80 million. NSF's CAREER program, which supports promising college and university faculty early in their careers, increases by $3.54 million to $149.46 million. This will support approximately 20 additional awards. Of NSF's three flagship graduate programs – Graduate Research Fellowships (GRF), Integrative Graduate Education and Research Traineeships (IGERT), and Graduate Teaching Fellowships in K-12 Education (GK-12) – support for GRF and IGERT will increase $4.28 million to $163.06 million. The GK-12 program, which complements NSF's K-12 efforts, will increase by $5.01 million to a total of $55.66 million. Stipends will be maintained at $30,000 and an estimated 4,665 students will be supported in FY 2007. A PART review of the Individuals investment category was completed for the FY 2005 Budget Request. The assessment found this set of programs to be "Effective."

Number of People Involved in NSF Activities



Institutions. Investments totaling $146.54 million in FY 2007, roughly level with FY 2006, enable colleges, universities, and other institutions to strengthen the quality of science and engineering education and increase the numbers of students attracted to science and engineering fields at all levels. Programs that enable these institutions to ensure adequate training for a wider portion of the science and engineering workforce include ADVANCE, which increases by $90,000 to $19.72 million, STEM Talent Expansion Program at $26.07 million, an increase of $50,000, and the Advanced Technological Education program at $45.92 million, an increase of $99,000. Engineering Education Reform decreases by $1.93 million to $13.02 million. A PART review of the Institutions investment category was completed for last year's Budget Request. The assessment found this set of programs to be "Effective."

Collaborations. Investments totaling $404.04 million, an increase of $15.67 million, will foster partnerships among colleges, universities, school districts, and other institutions – public, private, state, local, and federal – to strengthen science and engineering education at all levels and broaden participation in science and engineering fields. The FY 2007 budget continues to support a wide range of partnership programs and collaborations. In FY 2007, $104.07 million is designated for Discovery Research in K-12 (DR-K12). Other programs with significant increases include the Louis Stokes Alliances for Minority Participation ($39.66 million; an increase of $4.66 million), Alliances for Graduate Education and the Professoriate ($18.95 million; an increase of $4.45 million), Historically Black Colleges and Universities-Undergraduate Program (HBCU-UP) ($29.71 million; an increase of $4.53 million), and Informal Science Education ($66.64 million; an increase of $3.94 million). The Request includes total funding of $45.7 million, a decrease of $ 17.2 million, for the Math and Science Partnership (MSP) program. This investment continues support for five Teacher Institutes for the 21st Century to be awarded in FY 2006, designed to develop school-based intellectual leaders, and brings the total number of Teacher Institutes to 13. A PART review of the Collaborations investment category was completed for last year's Budget Request. The assessment found this set of programs to be "Effective."

Organizational Excellence (OE): *An agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices.*

NSF is committed to excellent, results-oriented management and stewardship. The FY 2007 Budget Request for Organizational Excellence totals $349.53 million, an increase of $36.44 million, or 11.6 percent, over the FY 2006 Current Plan of $313.09 million. In keeping with the President's Management Agenda, the FY 2007 request maintains NSF's commitment to providing outstanding customer service and to maintaining leadership in e-Government and state-of-the-art business practices.

The principal drivers of the FY 2007 investment in OE are Information Technology (IT), which increases by 56 percent, and the continued effort to strengthen the NSF workforce. The IT investments include increased spending for IT Security and a near three-fold increase for next-generation grants management capabilities, in keeping with NSF's designation as a Consortium lead for the Grants Management Line of Business. Other key investments include human capital management, professional development activities, and funding for award monitoring and oversight activities.

President's Management Agenda Scorecard

	Baseline	Status	Progress
	(Sep. 30, 2001)	(December 31, 2005)	
Strategic Management of Human Capital	R	G	Y
Competitive Sourcing	R	R	Y
Improving Financial Performance	G	G	G
Expanded E-Gov't.	Y	G	G
Budget and Performance Integration	R	G	G

A major factor in shaping these investments has been the ongoing NSF Business Analysis, which is addressing the fundamental challenges facing NSF as it becomes a fully integrated organization with increased capabilities for working both within and across traditional disciplinary and organizational boundaries. This analysis concludes in FY 2006, but the implementation of approved recommendations will continue into the foreseeable future as NSF perseveres in redefining excellence in all of its business efforts.

National Science Foundation FY 2007 Request
Summary of Major Changes by Account

(Dollars in Millions)

NSF FY 2006 Current Plan	**$5,581**
Research and Related Activities	
Biological Sciences	**+31**
Increases funding for research with emphases on enhancements for biological databases and informatics, continued planning for the National Ecological Observatory Network, broadening participation activities, Frontiers in Biological Research support on complex, multidimensional biology, and an increased number of awards.	
Computer and Information Science and Engineering	**+30**
Support for cybersecurity research and education increases substantially. Support is provided for the Center for Embedded Networked Sensing and the Center for Ubiquitous Secure Technology. Funding is also provided for the design and pre-construction development of the Global Environment for Network Innovations (GENI), which would allow for experimental research on a "clean-slate" reinvention of the internet that builds in security and robustness and that creates new applications capabilities.	
Engineering	**+48**
Increases funding for added support of disciplinary and interdisciplinary research projects; strengthens investment in Industry and University Cooperative Research Centers; and provides new funding for Emerging Frontiers in Engineering Research and Education. Within the increase is $20.0 million to support sensor research that is relevant to the detection of explosive devices and related threats.	
Geosciences	**+42**
Increases funding for preparation of the Ocean Observatories Initiative, supports two Science and Technology Centers initiated in FY 2006 -- the Center for Atmospheric Process Modeling and the Center for Coastal Margin Observation / Prediction. Increased funding will enable 65 new research grants while maintaining award size and duration of existing grants. Support for cyberinfrastructure initiatives increases.	
Mathematical and Physical Sciences	**+65**
Emphasis is on strengthening investments across the MPS portfolio. Themes to be emphasized include: Physics of the Universe, Fundamental Mathematical and Statistical Science, Physical Sciences at the Nanoscale, Cyberinfrastructure and the Cyberscience it Enables, and the Molecular Basis of Life Processes. Includes a $15 million investment to reinforce NSF support for university-based research in elementary particle physics.	

National Science Foundation FY 2007 Request
Summary of Major Changes by Account

(Dollars in Millions)

Social, Behavioral and Economic Sciences	**+14**
Increases funding for Science Metrics and maintains or increases support for core research such as the Innovation and Organizational Change program and for the Human and Social Dynamics priority area. Added funding for core programs will allow a greater number of proposals to be supported and funding rates to increase.	
Office of Cyberinfrastructure	**+55**
Initiates the four-year acquisition, at $50 million per year, of a leadership-class high performance computing (HPC) system, complementing ongoing investments in mid-range HPC platforms. Funding is also increased to support the development and provision of production-quality software services focused on strategic data- and collaboration-intensive functionalities.	
Office of International Science and Engineering	**+6**
Funding is increased for OISE's Partnerships for International Research and Education program and for the International Research Experiences for Students program. These increases are offset partly by reduced support for workshops, planning visits, and co-funding with other NSF directorates and offices.	
Office of Polar Programs	**+49**
Support increases for research, especially for International Polar Year (IPY) activities focusing on Study of Environmental Arctic Change (SEARCH), Polar Ice Sheet Dynamics and Stability, and Life in the Cold and Dark. Provides support for a new Science and Technology Center -- the Center for the Remote Sensing of Ice Sheets. Support for facilities and infrastructure increases, principally to support IPY activities and to explore Antarctic resupply options. Funding for polar icebreaking declines slightly.	
Integrative Activities	**-6**
Decreased funding reflects the transfer of $11.84 million in start-up funding for four Science and Technology Centers to the managing directorates (BIO-1), (GEO-2), and (MPS-1); provides additional support to existing Science of Learning Centers; and increases funding for the Partnerships for Innovation program, and for the acquisition of research instrumentation.	
Arctic Research Commission	**0**
Increased support of $280,000 reflects funding for one additional FTE, bringing the total FTE to four, and for increased administrative costs.	
Subtotal, R&RA	**+334**

National Science Foundation FY 2007 Request
Summary of Major Changes by Account

(Dollars in Millions)

Education and Human Resources	**+20**
Funding for the new Discovery Research K-12 program increases significantly from the FY 2006 Current Plan, as does support for EHR's broadening participation portfolio. Support for the Graduate Teaching Fellows in K-12 Education program, the Integrative Graduate Education and Research Traineeships program and the Graduate Research Fellowships program all increase above the FY 2006 Current Plan. Support also increases for the new Excellence Awards in Science and Engineering program, and for the Scholarships for Service program. Math and Science Partnership funding will be continued for all existing projects including new awards made in FY 2006. Funding decreases from the FY 2006 Current Plan level for the Research and Evaluation on Education in Science and Engineering program and the Course, Curriculum and Laboratory Improvement program. As planned, support for the Higher Education Centers of Learning and Teaching ends in FY 2006. No funds are requested for the Academies for Young Scientists program, which will be piloted in FY 2006.	
Major Research Equipment and Facilities Construction	**+50**
Provides funding for two new starts: Alaska Region Research Vessel (ARRV) and the Ocean Observatories Initiative (OOI) and provides FY 2007 funding for six ongoing projects: ALMA, EarthScope, IceCube, NEON, Scientific Ocean Drilling Vessel and South Pole Station Modernization. Also provides funding to reimburse the DOJ Judgment Fund for a settlement related to the Polar Aircraft Upgrades project.	
Salaries and Expenses	**+35**
Requests an additional 22 FTE to address increased workload and strengthen post-award monitoring and oversight of large facility projects. Funding increases for IT include support for NSF as a Grants Management Line of Business consortia provider. The Business Analysis study concludes in FY 2006, so no funds are requested in FY 2007 for this effort.	
National Science Board	**0**
Office of Inspector General	**+1**
Increased funding supports anticipated increases in personnel cost-of-living expenses and two additional FTE.	
Total Change, NSF	**+439**
NSF FY 2007 Request Level	**$6,020**

Totals may not add due to rounding.

NSF Summary Tables
FY 2007 Budget Request to Congress

(Dollars in Millions)

NSF by Account	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	FY 2007 Request: $ Change over FY 2005 Actual	% Change over FY 2005 Actual	$ Change over FY 2006 Current Plan	% Change over FY 2006 Current Plan
BIO	$576.78	$576.69	$607.85	$31.07	5.4%	$31.16	5.4%
CISE	490.20	496.41	526.69	36.49	7.4%	30.28	6.1%
ENG *(less SBIR/STTR)*	454.34	480.56	519.67	65.33	14.4%	39.11	8.1%
SBIR/STTR	102.75	100.36	108.88	6.13	6.0%	8.52	8.5%
GEO	697.17	702.83	744.85	47.68	6.8%	42.02	6.0%
MPS	1,069.36	1,085.45	1,150.30	80.94	7.6%	64.85	6.0%
SBE	196.80	199.91	213.76	16.96	8.6%	13.85	6.9%
OCI	123.40	127.12	182.42	59.02	47.8%	55.30	43.5%
OISE[1/]	43.38	34.52	40.61	-2.77	-6.4%	6.09	17.6%
OPP	348.53	389.34	438.10	89.57	25.7%	48.76	12.5%
IA	130.92	137.12	131.37	0.45	0.3%	-5.75	-4.2%
ARC	1.19	1.17	1.45	0.26	21.8%	0.28	23.9%
Research & Related Activities	**$4,234.82**	**$4,331.48**	**$4,665.95**	**$431.13**	**10.2%**	**$334.47**	**7.7%**
Education & Human Resources	**$843.54**	**$796.69**	**$816.22**	**-$27.32**	**-3.2%**	**$19.53**	**2.5%**
Major Research Equipment & Facilities Construction[2/]	**$165.14**	**$190.88**	**$240.45**	**$75.31**	**45.6%**	**$49.57**	**26.0%**
Salaries & Expenses	**$223.45**	**$246.81**	**$281.82**	**$58.37**	**26.1%**	**$35.01**	**14.2%**
National Science Board	**$3.65**	**$3.95**	**$3.91**	**$0.26**	**7.1%**	**-$0.04**	**-1.0%**
Office of Inspector General	**$10.17**	**$11.36**	**$11.86**	**$1.69**	**16.6%**	**$0.50**	**4.4%**
Total, NSF	**$5,480.78**	**$5,581.17**	**$6,020.21**	**$539.43**	**9.8%**	**$439.04**	**7.9%**

(Dollars in Millions)

NSF by Strategic Goal	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	FY 2007 Request: $ Change over FY 2005 Actual	% Change over FY 2005 Actual	$ Change over FY 2006 Current Plan	% Change over FY 2006 Current Plan
Ideas[1/]	$2,739.08	$2,748.31	$2,915.02	$175.94	6.4%	$166.71	6.1%
Tools	1,399.44	1,488.12	1,685.24	285.80	20.4%	197.12	13.2%
People	1,062.19	1,031.65	1,070.42	8.23	0.8%	38.77	3.8%
Organizational Excellence	280.07	313.09	349.53	69.46	24.8%	36.44	11.6%
Total, NSF	**$5,480.78**	**$5,581.17**	**$6,020.21**	**$539.43**	**9.8%**	**$439.04**	**7.9%**

Totals may not add due to rounding.

1/ OISE and Ideas FY 2005 Actual includes $9.42 million provided to NSF by the U.S. State Department for an award to the U.S. Civilian Research and Development Foundation.

2/ Total funding for FY 2006 MREFC also includes an unobligated balance of $14.88 million carried over from FY 2005, distributed pro-rata to the ALMA, EarthScope, IceCube and SODV projects. Including this amount, the MREFC account total is $205.76 million in FY 2006. For additional information, see the MREFC chapter.

National Science Foundation
By Strategic Outcome Goal and Account
FY 2007 Budget Request to Congress

(Dollars in Millions)

NSF Accounts	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request: Ideas	Tools	People	OrgExc	FY 2007 Request	Change over FY 2005 Actual: $	%	Change over FY 2006 Current Plan: $	%
FY 2005 Actual	**$5,480.78**		**$2,739.08**	**$1,399.44**	**$1,062.19**	**$280.07**					
FY 2006 Current Plan		**$5,581.17**	**$2,748.31**	**$1,488.12**	**$1,031.65**	**$313.09**					
BIO	$576.78	$576.69	$411.58	$124.79	$66.48	$5.00	$607.85	$31.07	5.4%	$31.16	5.4%
CISE	490.20	496.41	414.97	31.08	74.73	5.91	526.69	36.49	7.4%	30.28	6.1%
ENG *(less SBIR/STTR)*	454.34	480.56	390.75	30.67	90.25	8.00	519.67	65.33	14.4%	39.11	8.1%
SBIR/STTR	102.75	100.36	108.88	-	-	-	108.88	6.13	6.0%	8.52	8.5%
GEO	697.17	702.83	389.00	311.08	39.36	5.41	744.85	47.68	6.8%	42.02	6.0%
MPS	1,069.36	1,085.45	728.52	291.42	123.23	7.13	1,150.30	80.94	7.6%	64.85	6.0%
SBE	196.80	199.91	154.64	44.30	11.02	3.80	213.76	16.96	8.6%	13.85	6.9%
OCI	123.40	127.12	4.17	164.72	11.48	2.05	182.42	59.02	47.8%	55.30	43.5%
OISE[1/]	43.38	34.52	29.26	-	9.00	2.35	40.61	-2.77	-6.4%	6.09	17.6%
OPP	348.53	389.34	88.12	336.93	10.76	2.29	438.10	89.57	25.7%	48.76	12.5%
IA	130.92	137.12	27.90	94.28	9.19	-	131.37	0.45	0.3%	-5.75	-4.2%
ARC	1.19	1.17	1.45	-	-	-	1.45	0.26	21.8%	0.28	23.9%
Research & Related Activities	**$4,234.82**	**$4,331.48**	**$2,749.24**	**$1,429.27**	**$445.50**	**$41.94**	**$4,665.95**	**$431.13**	**10.2%**	**$334.47**	**7.7%**
Education & Human Resources	**$843.54**	**$796.69**	**$165.78**	**$15.52**	**$624.92**	**$10.00**	**$816.22**	**-$27.32**	**-3.2%**	**$19.53**	**2.5%**
Major Research Equipment & Facilities Construction[2/]	**$165.14**	**$190.88**	-	**$240.45**	-	-	**$240.45**	**$75.31**	**45.6%**	**$49.57**	**26.0%**
Salaries & Expenses	**$223.45**	**$246.81**	-	-	-	**$281.82**	**$281.82**	**$58.37**	**26.1%**	**$35.01**	**14.2%**
National Science Board	**$3.65**	**$3.95**	-	-	-	**$3.91**	**$3.91**	**$0.26**	**7.1%**	**-$0.04**	**-1.0%**
Office of Inspector General	**$10.17**	**$11.36**	-	-	-	**$11.86**	**$11.86**	**$1.69**	**16.6%**	**$0.50**	**4.4%**
Total, National Science Foundation	**$5,480.78**	**$5,581.17**	**$2,915.02**	**$1,685.24**	**$1,070.42**	**$349.53**	**$6,020.21**	**$539.43**	**9.8%**	**$439.04**	**7.9%**
H-1B Visa	*$25.95*	*$100.00*					*$100.00*				
Total NSF, Including H-1B Visa	*$5,506.73*	*$5,681.17*	*$2,915.02*	*$1,685.24*	*$1,070.42*	*$349.53*	*$6,120.21*	*$613.48*	*11.1%*	*$439.04*	*7.7%*
Percent Increase over Prior Year, excluding H-1B Visa			**6.1%**	**13.2%**	**3.8%**	**11.6%**					

Totals may not add due to rounding.

[1/] OISE FY 2005 Actual includes $9.42 million provided to NSF by the U.S. State Department for an award to the U.S. Civilian Research and Development Foundation.

[2/] Total funding for FY 2006 MREFC also includes an unobligated balance of $14.88 million carried over from FY 2005, distributed pro-rata to the ALMA, EarthScope, IceCube and SODV projects. Including this amount, the MREFC account total is $205.76 million in FY 2006. For additional information, see the MREFC chapter.

National Science Foundation
By Strategic Outcome Goal and Investment Category
FY 2007 Budget Request to Congress

(Dollars in Millions)

Strategic Outcome Goals and Investment Categories	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2005 Actual		Change over FY 2006 Current Plan	
				Amount	Percent	Amount	Percent
Fundamental Science & Engineering[1/]	$2,283.43	$2,270.88	$2,413.72	$130.29	5.7%	$142.84	6.3%
Centers Programs	236.67	253.25	259.78	23.11	9.8%	6.53	2.6%
Capability Enhancement	218.98	224.18	241.52	22.54	10.3%	17.34	7.7%
IDEAS	**$2,739.08**	**$2,748.31**	**$2,915.02**	**$175.94**	**6.4%**	**$166.71**	**6.1%**
Facilities	475.13	514.32	580.30	105.17	22.1%	65.98	12.8%
Infrastructure & Instrumentation	464.04	479.40	565.30	101.26	21.8%	85.90	17.9%
Polar Tools, Facilities & Logistics	278.16	306.95	345.56	67.40	24.2%	38.61	12.6%
Federally-Funded R&D Centers	182.10	187.45	194.08	11.98	6.6%	6.63	3.5%
TOOLS	**$1,399.44**	**$1,488.12**	**$1,685.24**	**$285.80**	**20.4%**	**$197.12**	**13.2%**
Individuals	522.22	496.36	519.84	-2.38	-0.5%	23.48	4.7%
Institutions	145.28	146.92	146.54	1.26	0.9%	-0.38	-0.3%
Collaborations	394.69	388.37	404.04	9.35	2.4%	15.67	4.0%
PEOPLE	**$1,062.19**	**$1,031.65**	**$1,070.42**	**$8.23**	**0.8%**	**$38.77**	**3.8%**
ORGANIZATIONAL EXCELLENCE	**$280.07**	**$313.09**	**$349.53**	**$69.46**	**24.8%**	**$36.44**	**11.6%**
TOTAL, NSF	**$5,480.78**	**$5,581.17**	**$6,020.21**	**$539.43**	**9.8%**	**$439.04**	**7.9%**

Strategic Outcome Goals as a Percent of NSF Budget

Strategic Outcome Goals	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request
Ideas[1/]	50.0%	49.2%	48.4%
Tools	25.5%	26.7%	28.0%
People	19.4%	18.5%	17.8%
Organizational Excellence	5.1%	5.6%	5.8%
Total, NSF	100.0%	100.0%	100.0%

[1/] FY 2005 Actual IDEAS and Fundamental Science and Engineering includes $9.42 million provided to NSF Office of International Science and Engineering (OISE) by the U.S. State Department for an award to the U.S. Civilian Research and Development Foundation.

National Science Foundation
Tools by Investment Category
FY 2007 Budget Request to Congress

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Facilities[1,2,3]	**$475.13**	**$514.32**	**$580.30**	**$65.98**	**12.8%**
Academic Research Fleet	83.20	84.60	97.70	13.10	15.5%
Regional Class Research Vessels	*2.00*	*3.60*	*15.10*	11.50	319.4%
RHOV Construction (R/V Alvin Replacement)	*2.23*	*5.50*	*5.10*	*-0.40*	*-7.3%*
R/V Langseth Construction (R/V Ewing Replacement)	*8.00*	*2.50*	-	*-2.50*	*-100.0%*
Other Academic Research Fleet	*70.97*	*73.00*	*77.50*	*4.50*	*6.2%*
Advanced Modular Incoherent Scatter Radar	10.50	8.00	-	-8.00	-100.0%
Cornell Electron Storage Ring	16.62	14.56	14.71	0.15	1.0%
Gemini	15.48	18.26	20.00	1.74	9.5%
Incorporated Research Institutions for Seismology	11.90	12.00	12.90	0.90	7.5%
Large Hadron Collider	10.51	13.36	18.00	4.64	34.7%
Laser Interferometer Gravitational Wave Observatory	32.00	31.68	33.00	1.32	4.2%
Major Research Equipment & Facilities Construction[1/]	165.60	209.83	284.97	75.14	35.8%
Nanofabrication (NNIN)	13.90	13.76	13.89	0.13	0.9%
National High Magnetic Field Laboratory	25.50	25.74	26.50	0.76	3.0%
National Superconducting Cyclotron Laboratory	17.50	17.32	17.60	0.28	1.6%
Network for Earthquake Engineering Simulation	17.94	20.31	21.27	0.96	4.7%
Integrated Ocean Drilling Pgm/Ocean Drilling Program	40.19	31.80	6.50	-25.30	-79.6%
Other Facilities[2/]	14.29	13.10	13.26	0.16	1.2%
Infrastructure & Instrumentation	**$464.04**	**$479.40**	**$565.30**	**$85.90**	**17.9%**
Major Research Instrumentation	89.26	88.39	90.00	1.61	1.8%
National STEM Digital Library	20.30	17.61	18.11	0.50	2.8%
Research Resources	213.31	244.97	265.16	20.19	8.2%
Science Resource Statistics	25.49	24.69	27.31	2.62	10.6%
Shared Cyberinfrastructure Tools	115.68	103.74	164.72	60.98	58.8%
Polar Tools, Facilities and Logistics[3/]	**$278.16**	**$306.95**	**$345.56**	**$38.61**	**12.6%**
Antarctic Facilities and Operations	146.53	141.76	161.09	19.33	13.6%
Antarctic Logistics	70.26	66.66	67.52	0.86	1.3%
Arctic Logistics	35.06	35.20	44.90	9.70	27.6%
Icebreakers O&M Reprogramming	9.20	58.20	57.00	-1.20	-2.1%
Polar Environment, Safety & Health	0.25	5.13	5.92	0.79	15.4%
South Pole Station[1/]	16.86	-	9.13	9.13	N/A
Federally-funded R&D Centers	**$182.10**	**$187.45**	**$194.08**	**$6.63**	**3.5%**
National Astronomy & Ionosphere Center	12.42	12.16	12.16	-	-
National Center for Atmospheric Research	80.68	83.36	86.85	3.49	4.2%
National Optical Astronomy Observatories	37.94	36.91	40.05	3.14	8.5%
National Radio Astronomy Observatories	47.03	50.74	50.74	-	-
Science and Technology Policy Institute	4.03	4.28	4.28	-	-
Total, Tools Support	**$1,399.44**	**$1,488.12**	**$1,685.24**	**$197.12**	**13.2%**

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/] Other Facilities includes support for other physics and materials research facilities.

[3/] Polar Tools, Facilities and Logistics includes South Pole Station, an MREFC project, with funding as described above.

National Science Foundation
Selected Crosscutting Programs
FY 2007 Budget Request to Congress

(Dollars in Millions)

Selected Crosscutting Programs		FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	FY 2007 Request: Change over FY 2005 Actual: Amount	Percent	Change over FY 2006 Current Plan: Amount	Percent
ADVANCE	Research & Related Activities	19.86	19.63	19.72	-0.14	-0.7%	0.09	0.5%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$19.86**	**$19.63**	**$19.72**	**-$0.14**	**-0.7%**	**$0.09**	**0.5%**
Course, Curriculum & Lab Improvement - CCLI	Research & Related Activities	1.83	1.34	1.84	0.01	0.5%	0.50	27.2%
	Education & Human Resources	41.93	36.93	33.30	-8.63	-20.6%	-3.63	-10.9%
	Total, NSF	**$43.76**	**$38.27**	**$35.14**	**-$8.62**	**-19.7%**	**-$3.13**	**-8.9%**
Faculty Early Career Development - CAREER	Research & Related Activities	162.71	145.92	149.46	-13.25	-8.1%	3.54	2.4%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$162.71**	**$145.92**	**$149.46**	**-$13.25**	**-8.1%**	**$3.54**	**2.4%**
Graduate Research Fellowships - GRF	Research & Related Activities	8.07	7.99	8.06	-0.01	-0.1%	0.07	0.9%
	Education & Human Resources	87.87	85.37	88.03	0.16	0.2%	2.66	3.0%
	Total, NSF	**$95.94**	**$93.36**	**$96.09**	**$0.15**	**0.2%**	**$2.73**	**2.8%**
Graduate Teaching Fellowships in K-12 Education - GK-12	Research & Related Activities	7.77	7.60	8.86	1.09	14.0%	1.26	14.2%
	Education & Human Resources	41.66	43.05	46.80	5.14	12.3%	3.75	8.0%
	Total, NSF	**$49.43**	**$50.65**	**$55.66**	**$6.23**	**12.6%**	**$5.01**	**9.0%**
Integrative Graduate Education and Research Training - IGERT	Research & Related Activities	43.28	41.99	42.40	-0.88	-2.0%	0.41	1.0%
	Education & Human Resources	24.31	23.43	24.57	0.26	1.1%	1.14	4.6%
	Total, NSF	**$67.59**	**$65.42**	**$66.97**	**-$0.62**	**-0.9%**	**$1.55**	**2.3%**
Long-Term Research Sites - LTER	Research & Related Activities	22.26	23.07	24.72	2.46	11.1%	1.65	6.7%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$22.26**	**$23.07**	**$24.72**	**$2.46**	**11.1%**	**$1.65**	**6.7%**
Postodoctoral Programs	Research & Related Activities	16.59	16.01	16.04	-0.55	-3.3%	0.03	0.2%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$16.59**	**$16.01**	**$16.04**	**-$0.55**	**-3.3%**	**$0.03**	**0.2%**
Research Experience for Teachers - RET	Research & Related Activities	5.47	8.39	8.51	3.04	55.6%	0.12	1.4%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$5.47**	**$8.39**	**$8.51**	**$3.04**	**55.6%**	**$0.12**	**1.4%**
Research Experience for Undergraduates - REU	Research & Related Activities	55.72	55.82	56.92	1.20	2.2%	1.10	1.9%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$55.72**	**$55.82**	**$56.92**	**$1.20**	**2.2%**	**$1.10**	**1.9%**
Research Experience for Undergraduates - REU - Sites Only	Research & Related Activities	35.87	34.73	35.64	-0.23	-0.6%	0.91	2.6%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$35.87**	**$34.73**	**$35.64**	**-$0.23**	**-0.6%**	**$0.91**	**2.6%**
Research Experience for Undergraduates - REU - Supplements Only	Research & Related Activities	19.85	21.09	21.28	1.43	7.2%	0.19	0.9%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$19.85**	**$21.09**	**$21.28**	**$1.43**	**7.2%**	**$0.19**	**0.9%**
Research Opportunity Awards - ROA	Research & Related Activities	1.35	1.15	1.17	-0.18	-13.0%	0.02	1.7%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$1.35**	**$1.15**	**$1.17**	**-$0.18**	**-13.0%**	**$0.02**	**1.7%**
Research in Undergraduate Institutions - RUI	Research & Related Activities	27.59	29.68	29.78	2.19	7.9%	0.10	0.3%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$27.59**	**$29.68**	**$29.78**	**$2.19**	**7.9%**	**$0.10**	**0.3%**
Science and Technology Centers - STCs	Research & Related Activities	49.65	62.38	67.48	17.83	35.9%	5.10	7.6%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$49.65**	**$62.38**	**$67.48**	**$17.83**	**35.9%**	**$5.10**	**7.6%**

Totals may not add due to rounding.

National Science Foundation
Funding for Priority Areas: FY 2000 - FY 2008

(Dollars in Millions)

	FY 2000 Actual	FY 2001 Actual	FY 2002 Actual	FY 2003 Actual	FY 2004 Actual	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	FY 2008 Estimate
Biocomplexity in the Environment	$50.00	$54.88	$58.96	$70.28	$104.11	$99.17	$83.36	$42.58	-
Information Technology Research	126.00	261.17	277.22	335.11	308.80	-	-	-	-
Mathematical Sciences	-	-	30.00	60.42	91.56	89.56	87.97	78.45	-
Nanoscale Science and Engineering	-	149.68	192.28	222.46	256.05	288.33	244.33	-	-
Human and Social Dynamics	-	-	-	4.46	30.07	38.31	39.45	41.45	42.00
Total, Priority Areas	$176.00	$465.73	$558.46	$692.73	$790.59	$515.37	$455.11	$162.48	$42.00

Funding for the Biocomplexity in the Environment and Mathematical Sciences Priority Areas will return to the core following FY 2007.

NSF Funding Profile

Approximately half of the awards 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.

Statistics for Competitive Awards: The Funding Rate is the number of competitive awards made during a year as a percentage of total proposals competitively reviewed. This indicates the probability of winning an award when submitting proposals to NSF.

Statistics for Research Grants: Research Grants are grants limited to research projects and exclude other categories of awards that fund infrastructure-type activities which do not require multi-year support, such as equipment and conference awards. Annualized Award Size shows 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 length of the award in years.

The Quantitative Data Tables, provided under a separate tab in this submission, 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 2005 Estimate	FY 2006 Estimate	FY 2007 Request Estimate
Statistics for Competitive Awards			
Number	9,765	9,760	10,310
Funding Rate	23%	23%	24%
Statistics for Research Grants			
Number of Research Grants	6,185	6,190	6,760
Funding Rate	20%	20%	21%
Median Annualized Award Size	$108,600	$108,900	$111,800
Average Annualized Award Size	$143,700	$143,000	$148,300
Average Duration (years)	3.0	3.0	3.0

National Science Foundation NSTC Crosscuts
FY 2007 Budget Request to Congress

(Dollars in Millions)

	Climate Change Science Program Includes U.S. Global Change Research Program Climate Change Research Initiative			Networking and Information Technology Research and Development			National Nanotechnology Initiative		
	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request
BIO	$15.10	$15.10	$15.10	$77.00	$77.00	$83.50	$46.78	$49.00	$52.55
CISE	-	-	-	490.20	496.41	526.69	7.78	12.00	12.87
ENG	1.00	1.00	1.00	11.20	11.20	11.20	123.77	127.77	137.02
GEO	150.35	149.35	157.72	14.56	14.56	14.56	7.94	9.00	9.65
MPS	5.45	5.45	5.45	77.52	67.82	69.00	143.27	141.54	156.42
SBE	15.48	15.48	15.48	12.47	12.47	12.47	1.57	1.56	1.67
OCI	-	-	-	123.28	127.12	182.42	-	-	-
OISE	-	-	-	0.38	-	-	0.72	-	-
OPP	10.50	10.50	10.50	-	-	-	-	-	-
IA	-	-	-	-	-	-	-	-	-
ARC	-	-	-	-	-	-	-	-	-
Research and Related Activities	**$197.88**	**$196.88**	**$205.25**	**$806.61**	**$806.58**	**$899.84**	**$331.83**	**$340.87**	**$370.18**
Education and Human Resources	-	-	-	**$4.06**	**$3.75**	**$3.90**	**$3.16**	**$2.90**	**$3.00**
Major Research Equipment and Facilities Construction	-	-	-	-	-	-	-	-	-
NSF Total	**$197.88**	**$196.88**	**$205.25**	**$810.67**	**$810.33**	**$903.74**	**$334.99**	**$343.77**	**$373.18**

National Science Foundation
Homeland Security Activities
FY 2007 Budget Request to Congress

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Critical Infrastructure Protection	$286.41	$282.95	$304.34	$21.39	7.6%
Research to Combat Bioterrorism	27.00	27.00	28.00	1.00	3.7%
Microbial Genome Sequencing	*17.00*	*17.00*	*18.00*	*1.00*	*5.9%*
Ecology of Infectious Diseases	*10.00*	*10.00*	*10.00*	-	-
Counterterrorism	25.00	27.00	47.00	20.00	74.1%
Physical / Information Technology Security	2.99	4.87	4.87	-	-
TOTAL, NSF	**$341.40**	**$341.82**	**$384.21**	**$42.39**	**12.4%**

NSF Programs to Broaden Participation
FY 2007 Budget Request to Congress

Estimated Investments
(Dollars in Millions)

Program	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change Over FY 2006 Amount	Change Over FY 2006 Percent
Programs for Minority Individuals					
Alliances for Graduate Education and the Professoriate (EHR)	$15.00	$14.50	$18.95	$4.45	30.7%
Funding for W/M/D High School Students (ENG)	1.55	1.57	1.60	0.03	1.9%
GRFs to Members of Underrepresented Groups (EHR)	7.29	7.09	7.31	0.22	3.1%
Louis Stokes Alliances for Minority Participation (EHR)	35.61	35.00	39.66	4.66	13.3%
Minority Post-Docs	3.30	3.40	3.40	-	-
SBE Minority postdocs	*0.90*	*0.90*	*0.90*	-	-
BIO Minority postdocs	*2.40*	*2.50*	*2.50*	-	-
Opportunities to Enhance Diversity in the Geosciences	4.89	4.80	4.80	-	-
Research Initiation Grants / Career Advancement Awards (BIO)	2.70	3.70	5.70	2.00	54.1%
SOARS (GEO)	0.45	0.45	0.45	-	-
Mentoring in Biology	0.50	3.00	5.00	2.00	66.7%
Total, Programs for Minority Individuals	**$71.29**	**$73.51**	**$86.87**	**$13.36**	**18.2%**
Programs for Minority Institutions					
CREST (EHR)	$15.60	$17.90	$24.94	$7.04	39.3%
HBCU-Undergraduate Program (EHR)	25.28	25.18	29.71	4.53	18.0%
Model Institutions for Excellence (EHR)	2.50	-	-	-	N/A
Partnerships for Research and Education in Materials (MPS)	2.00	3.80	4.00	0.20	5.3%
Tribal Colleges and Universities Program (EHR)	9.18	9.27	12.42	3.15	34.0%
Total, Programs for Minority Institutions	**$54.56**	**$56.15**	**$71.07**	**$14.92**	**26.6%**
Gender-Based Programs					
ADVANCE (R&RA)	$19.86	$19.63	$19.72	$0.09	0.5%
GRFs - Women in Engineering and Computer Science	8.07	7.99	8.06	0.07	0.9%
IT Workforce Research (CISE)	2.70	3.00	1.00	-2.00	-66.7%
Program for Gender Equity (EHR)	9.90	9.68	10.96	1.28	13.2%
Total, Gender-Based Programs	**$40.53**	**$40.30**	**$39.74**	**-$0.56**	**-1.4%**
Programs for Persons with Disabilities					
Research in Disabilities Education (EHR)	$5.04	$5.11	$5.77	$0.66	12.9%
Total, Programs for Persons with Disabilities	**$5.04**	**$5.11**	**$5.77**	**$0.66**	**12.9%**

NSF Programs to Broaden Participation
FY 2007 Budget Request to Congress

Estimated Investments
(Dollars in Millions)

Program	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change Over FY 2006 Amount	Change Over FY 2006 Percent
Other Broadening Participation Programs					
Advanced Technological Education (EHR)	$44.48	$44.93	$45.92	$0.99	2.2%
Broadening Participation in Computing (CISE)	3.70	14.00	14.00	-	-
Cyberinfrastructure Training, Education, Advancement and Mentoring (OCI)	5.51	10.00	10.00	-	-
EPSCoR (EHR)[1/]	93.08	98.37	99.65	1.28	1.3%
Graduate Research Supplements (ENG)	0.40	0.45	0.50	0.05	11.1%
H-1B Nonimmigrant Petitioner Fee programs	25.95	100.00	100.00	-	-
Informal Science Education	62.75	62.70	66.64	3.94	6.3%
Informal Science Education (EHR)	*62.75*	*62.70*	*65.64*	*2.94*	*4.7%*
Informal Science Education (OPP)	-	-	*1.00*	*1.00*	*N/A*
Math and Science Partnership (EHR)	78.83	62.88	45.70	-17.18	-27.3%
Noyce Scholarships (EHR)	7.57	8.77	9.77	1.00	11.4%
Partnerships for Innovation (R&RA)	9.92	9.00	9.19	0.19	2.1%
R&RA Integrative Collaborations	-	6.99	7.00	0.01	0.1%
BIO R&RA Integrative Collaborations	-	-	-	-	*N/A*
CISE R&RA Integrative Collaborations	-	*1.00*	*1.00*	-	-
ENG R&RA Integrative Collaborations	-	*1.00*	*1.00*	-	-
GEO R&RA Integrative Collaborations	-	*1.00*	*1.00*	-	-
MPS R&RA Integrative Collaborations	-	*1.00*	*1.00*	-	-
SBE R&RA Integrative Collaborations	-	*0.99*	*1.00*	*0.01*	*1.0%*
OISE R&RA Integrative Collaborations	-	*1.00*	*1.00*	-	-
OPP R&RA Integrative Collaborations	-	*1.00*	*1.00*	-	-
Research Partnerships for Diversity (MPS)	1.00	1.50	3.25	1.75	116.7%
STEM Talent Expansion Program (EHR)	24.53	25.57	26.07	0.50	2.0%
Total, Other Broadening Participation Programs	**$357.72**	**$445.16**	**$437.69**	**-$7.47**	**-1.7%**
Subtotal, R&RA	**66.55**	**93.28**	**98.67**	**5.39**	**5.8%**
Subtotal, EHR	**436.64**	**426.95**	**442.47**	**15.52**	**3.6%**
Subtotal, H-1B Nonimmigrant Petitioner Fees	**25.95**	**100.00**	**100.00**	**-**	**-**
Total, BROADENING PARTICIPATION PROGRAMS	**$529.14**	**$620.23**	**$641.14**	**$20.91**	**3.4%**

1/ Excludes R&RA co-funding for EPSCoR.

National Science Foundation
People Funding by Level of Education
FY 2007 Budget Request to Congress

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
K-12 Programs	$204.33	$177.88	$164.67	-$13.21	-7.4%
Undergraduate Programs	295.99	299.04	317.38	18.34	6.1%
Graduate & Professional Programs	464.83	456.22	476.68	20.46	4.5%
Other People Programs	97.04	98.51	111.69	13.18	13.4%
TOTAL, NSF	**$1,062.19**	**$1,031.65**	**$1,070.42**	**$38.77**	**3.8%**

Number of People Involved in NSF Activities

Almost 180,000 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 K-12 students, K-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.

Number of People Involved in NSF Activities

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Senior Researchers	32,400	31,920	32,990
Other Professionals	12,045	11,645	12,040
Postdoctoral Associates	5,465	5,360	5,605
Graduate Students	26,855	27,110	28,205
Undergraduate Students	32,120	27,290	28,795
K-12 Students	10,750	8,275	9,320
K-12 Teachers	73,430	59,480	60,530
Total Number of People	193,065	171,080	177,485

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 a doctoral degree 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. Roughly 97 percent of postdoctoral associates are supported through funds included in research projects, centers or facilities awards. Others are recipients of postdoctoral fellowships.

Graduate Students include students compensated from NSF grant funds. Approximately 16 percent 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 be assisting senior researchers or postdoctoral associates in performing research, or participating in NSF programs 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 the sciences and mathematics.

National Science Foundation By Account
(FY Actuals - Current 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
1951	$0.03	-	-	-	$0.13	-	-	$0.15
1952	1.40	1.54	-	-	0.53	-	-	3.47
1953	2.14	1.41	-	-	0.88	-	-	4.43
1954	4.52	1.89	-	-	1.55	-	-	7.96
1955	8.86	2.08	-	-	1.55	-	-	12.49
1956	10.79	3.52	-	-	1.68	-	-	15.99
1957	21.98	14.30	-	-	2.35	-	-	38.63
1958	27.37	19.21	-	-	2.93	-	-	49.51
1959	66.33	61.29	-	-	5.26	-	-	132.88
1960	88.35	63.74	-	-	6.51	-	-	158.60
1961	103.98	63.44	-	-	7.57	-	-	174.99
1962	173.26	78.58	-	-	8.98	-	-	260.82
1963	218.90	90.99	-	-	10.87	-	-	320.75
1964	239.95	102.58	-	-	12.05	-	-	354.58
1965	282.44	120.41	-	-	13.12	-	-	415.97
1966	328.63	124.31	-	-	13.09	-	-	466.02
1967	327.70	123.36	-	-	14.04	-	-	465.10
1968	350.20	134.71	-	-	15.38	-	-	500.29
1969	292.90	123.11	-	-	16.49	-	-	432.50
1970	316.41	126.41	-	-	19.68	-	-	462.49
1971	369.37	105.00	-	-	21.77	-	-	496.14
1972	482.43	93.73	-	-	24.56	-	-	600.72
1973	519.42	62.23	-	-	28.62	-	-	610.27
1974	533.29	80.71	-	-	31.66	-	-	645.65
1975	581.23	74.03	-	-	37.87	-	-	693.13
1976	619.72	62.48	-	-	42.23	-	-	724.42
1977	671.98	74.26	-	-	45.53	-	-	791.77
1978	734.69	73.86	-	-	48.70	-	-	857.25
1979	791.76	80.41	-	-	54.77	-	-	926.93
1980	836.83	80.06	-	-	58.24	-	-	975.13
1981	900.36	75.70	-	-	59.21	-	-	1,035.27
1982	909.75	26.20	-	-	63.18	-	-	999.14
1983	1,013.02	22.98	-	-	65.70	-	-	1,101.69
1984	1,177.70	62.97	-	-	66.26	-	-	1,306.92
1985	1,344.56	90.56	-	-	71.95	-	-	1,507.07
1986	1,329.64	91.69	-	-	71.84	-	-	1,493.17
1987	1,439.97	109.88	-	-	77.77	-	-	1,627.62
1988	1,481.31	156.79	-	-	84.47	-	-	1,722.57
1989	1,600.53	194.06	-	-	91.29	-	-	1,885.88
1990	1,696.56	230.41	0.41	-	96.35	2.33	-	2,026.06
1991	1,868.45	331.91	39.02	-	101.23	2.89	-	2,343.49
1992	1,940.48	459.44	33.36	-	109.99	3.86	-	2,547.13
1993	2,046.31	505.06	49.75	34.07	110.84	3.69	-	2,749.73
1994	2,168.36	569.03	105.38	17.04	123.49	3.92	-	2,987.21
1995	2,281.46	611.88	117.46	126.00	129.01	4.46	-	3,270.27
1996	2,327.80	601.16	70.89	70.00	132.50	3.98	-	3,206.33
1997	2,433.93	619.14	30.02	76.13	134.27	5.33	-	3,298.82
1998	2,572.62	633.16	-	78.21	136.95	4.80	-	3,425.73
1999	2,821.61	662.48	-	56.71	144.08	5.41	-	3,690.28
2000	2,979.90	683.58	-	105.00	149.28	5.60	-	3,923.36
2001	3,372.30	795.42	-	119.24	166.33	6.58	-	4,459.87
2002	3,615.97	866.11	-	115.35	169.93	6.70	-	4,774.06
2003	4,054.43	934.88	-	179.03	189.42	8.70	2.88	5,369.34
2004	4,293.34	944.10	-	183.96	218.92	9.47	2.22	5,652.01
2005	4,234.82	843.54	-	165.14	223.45	10.17	3.65	5,480.77
2006 Plan	4,331.48	796.69	-	190.88	246.81	11.36	3.95	5,581.17
2007 Request	4,665.95	816.22	-	240.45	281.82	11.86	3.91	6,020.21

NSF Total may not add due to rounding.

National Science Foundation By Account

(FY Actuals - FY 2005 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
1951	$0.16	-	-	-	$0.79	-	-	$0.95
1952	8.53	9.36	-	-	3.23	-	-	21.12
1953	12.77	8.42	-	-	5.23	-	-	26.42
1954	26.67	11.15	-	-	9.12	-	-	46.95
1955	51.83	12.17	-	-	9.04	-	-	73.04
1956	61.50	20.06	-	-	9.58	-	-	91.15
1957	120.74	78.55	-	-	12.91	-	-	212.21
1958	145.95	102.40	-	-	15.64	-	-	263.99
1959	348.22	321.75	-	-	27.61	-	-	697.58
1960	458.28	330.63	-	-	33.76	-	-	822.67
1961	531.74	324.44	-	-	38.71	-	-	894.89
1962	876.21	397.39	-	-	45.40	-	-	1,319.00
1963	1,093.29	454.43	-	-	54.27	-	-	1,601.99
1964	1,184.31	506.30	-	-	59.49	-	-	1,750.10
1965	1,370.42	584.24	-	-	63.65	-	-	2,018.31
1966	1,561.15	590.54	-	-	62.18	-	-	2,213.87
1967	1,508.08	567.71	-	-	64.63	-	-	2,140.42
1968	1,556.40	598.69	-	-	68.34	-	-	2,223.43
1969	1,244.85	523.23	-	-	70.08	-	-	1,838.17
1970	1,275.11	509.43	-	-	79.29	-	-	1,863.84
1971	1,417.73	403.02	-	-	83.56	-	-	1,904.30
1972	1,768.20	343.54	-	-	90.02	-	-	2,201.77
1973	1,823.40	218.46	-	-	100.47	-	-	2,142.32
1974	1,746.05	264.25	-	-	103.65	-	-	2,113.95
1975	1,723.75	219.55	-	-	112.30	-	-	2,055.60
1976	1,714.21	172.83	-	-	116.80	-	-	2,003.84
1977	1,801.59	199.09	-	-	122.07	-	-	2,122.75
1978	1,890.62	190.08	-	-	125.31	-	-	2,206.01
1979	1,908.95	193.86	-	-	132.04	-	-	2,234.85
1980	1,867.19	178.63	-	-	129.95	-	-	2,175.77
1981	1,847.02	155.29	-	-	121.46	-	-	2,123.77
1982	1,699.82	48.95	-	-	118.05	-	-	1,866.82
1983	1,771.52	40.18	-	-	114.89	-	-	1,926.59
1984	1,972.42	105.45	-	-	110.97	-	-	2,188.84
1985	2,171.76	146.27	-	-	116.21	-	-	2,434.24
1986	2,080.10	143.44	-	-	112.38	-	-	2,335.93
1987	2,201.49	167.99	-	-	118.89	-	-	2,488.37
1988	2,207.07	233.61	-	-	125.85	-	-	2,566.53
1989	2,311.97	280.32	-	-	131.86	-	-	2,724.16
1990	2,359.03	320.38	0.57	-	133.97	3.24	-	2,817.19
1991	2,504.99	444.98	52.31	-	135.71	3.87	-	3,141.86
1992	2,507.43	593.68	43.10	-	142.13	4.98	-	3,291.32
1993	2,579.32	636.62	62.71	42.94	139.71	4.65	-	3,465.95
1994	2,672.54	701.34	129.88	21.01	152.20	4.83	-	3,681.80
1995	2,752.77	738.28	141.72	152.03	155.67	5.38	-	3,945.85
1996	2,750.78	710.40	83.78	82.72	156.57	4.70	-	3,788.95
1997	2,822.01	717.86	34.81	88.27	155.68	6.18	-	3,824.81
1998	2,931.64	721.52	-	89.12	156.06	5.47	-	3,903.80
1999	3,176.82	745.88	-	63.84	162.22	6.09	-	4,154.86
2000	3,311.58	759.67	-	116.69	165.90	6.22	-	4,360.05
2001	3,673.45	866.45	-	129.89	181.18	7.17	-	4,858.14
2002	3,848.06	921.70	-	122.75	180.84	7.13	-	5,080.48
2003	4,233.60	976.19	-	186.94	197.79	9.08	3.01	5,606.62
2004	4,396.25	966.73	-	188.37	224.17	9.70	2.27	5,787.49
2005	4,234.82	843.54	-	165.14	223.45	10.17	3.65	5,480.77
2006 Plan	4,215.39	775.34	-	185.76	240.19	11.06	3.84	5,431.58
2007 Request	4,429.30	774.82	-	228.25	267.53	11.26	3.71	5,714.87

NSF Total may not add due to rounding.

Current Authorizations -- National Science Foundation

LEGISLATION	FY 2005 Actual	Authorization Levels FY 2005	FY 2006	FY 2007	FY 2006 Enacted Levels[2]
		(Dollars in Millions)			
National Science Foundation Act of 1950 (P.L. 81-507) [1]					
Scholarships and Graduate Fellowships	*within limits of funds made available for this purpose*				
General Authority	*within the limits of available appropriations*				
Administering Provisions	*to make such expenditures as may be necessary*				
International Cooperation and Coordination with Foreign Policy	*within the limit of appropriated funds*				
Contract Arrangements	*utilize appropriations available*				
NSF Authorization Act of 2002 (P.L.107-368)					
NSF, Total	$5,480.78	$7,378.34	$8,519.78	$9,839.26	$5,581.17
Account Specific					
Research and Related Activities	$4,234.82	$5,543.79	*	*	$4,331.48
Education and Human Resources	$843.54	$1,330.77	*	*	$796.69
Major Research Equipment and Facilities Construction	$165.14	$258.88	*	*	$190.88
Salaries and Expenses	$223.45	$231.34	*	*	$246.81
National Science Board	$3.65	$4.25	*	*	$3.95
Office of Inspector General	$10.17	$9.32	*	*	$11.36
Program Specific					
Math and Science Partnership (MSP) - *strengthens math and science education through partnerships between state and local school districts and institutions of higher education*	$78.83	$400.00	*	*	$62.88
Robert Noyce Scholarship Program - *encourages science, technology, engineering and mathematics (STEM) majors and professionals to become math and science teachers*	$7.57	$20.00	*	*	$8.77
STEM Talent Expansion Program (STEP) or "tech talent" expansion - *increases U.S. citizens or permanent residents receiving STEM associate or bachelor's degrees*	$24.53	$35.00	*	*	$25.57

[1] Organic language establishing NSF, authorization and appropriation language may not correspond to current accounts and programs.

[2] H.Rep.109-272, conference report accompanying H.R.2862, Science, State, Justice, Commerce, and Related Agencies Appropriations Act, 2006, which became P.L.109-108; includes rescissions of 0.28% (Sec. 638; P.L.109-108) and 1% (Chapter 8, Sec. 3801; P.L.109-148, Department of Defense, Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and Pandemic Influenza Act, 2006).

[*] After FY 2005, authorization levels not specified below agency level.

Cyber Security Research and Development Act (P.L.107-305)					
Program Specific					
Computer and Network Security Capacity Building Grants	$20.00	$20.00	$20.00	$20.00	$17.00
Computer and Network Security Research Centers	$16.00[3]	$36.00	$36.00	$36.00	$15.00
Computer and Network Security Research Grants	$40.00[3]	$46.00	$52.00	$60.00	$39.00
Graduate Traineeships in Computer and Network Security	$11.4[4]	$20.00	$20.00	$20.00	$11.00
21st Century Nanotechnology Research and Development Act (P.L.108-153)					
Nanoscale Science and Engineering	$334.99	$385.00	$424.00	$449.00	$343.77
National Earthquake Hazards Reduction Program Reauthorization Act of 2003 (P.L.108-360)	$53.10	$38.00	$39.10	$40.31	$53.77
National Windstorm Impact Reduction Act of 2004 (P.L.108-360)	$35.40	N/A	$8.70	$9.40	**
Consolidated Appropriations Act, 2001 (P.L.106-554); Small Business Technology Transfer Program Reauthorization Act of 2001 (P.L.107-50)					
Small Business Innovation Research (SBIR) Program	$91.96				$89.84
Small Business Technology Transfer (STTR) Program	$10.79	0.3% of research funds (STTR)			$10.52

[3] Excludes graduate student support for US citizens and permanent residents.
[4] Estimate of graduate student support provided to US citizens and permanent residents through research grants and center awards; excludes tuition and benefits.
** Actual amounts will be reported after awards are completed.

RESEARCH AND RELATED ACTIVITIES $4,665,950,000

The FY 2007 Budget Request for the Research and Related Activities (R&RA) Appropriation is $4,665.95 million, an increase of $334.47 million, or 7.7 percent, above the FY 2006 Current Plan of $4,331.48 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.

The R&RA portfolio for FY 2007 emphasizes priorities that will strengthen the science and engineering enterprise through investments in frontier research and cutting-edge research tools. The fruits of research in science, engineering, and technology have steadily lifted America's standard of living. In every sector, every community, and every region, discovery, learning, and innovation are the dynamos driving wealth-producing growth and job creation. America has always measured her progress not through comparisons with traditional standards, but by pursuing unmet challenges and venturing into unexplored territory. Today, however, this is becoming increasingly difficult. Intense competition for ideas and talent, for comparative advantage and market opportunities, are felt worldwide. Robust investments are now more fundamentally critical than ever before.

Research and Related Activities
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biological Sciences	$576.78	$576.69	$607.85	$31.16	5.4%
Computer and Information Science and Engineering	490.20	496.41	526.69	30.28	6.1%
Engineering	557.09	580.92	628.55	47.63	8.2%
Geosciences	697.17	702.83	744.85	42.02	6.0%
Mathematical and Physical Sciences	1,069.36	1,085.45	1,150.30	64.85	6.0%
Social, Behavioral and Economic Sciences	196.80	199.91	213.76	13.85	6.9%
Office of Cyberinfrastructure	123.40	127.12	182.42	55.30	43.5%
Office of International Science and Engineering[1]	43.38	34.52	40.61	6.09	17.6%
U.S. Polar Research Programs	278.27	322.68	370.58	47.90	14.8%
U.S. Antarctic Logistical Support Activities	70.26	66.66	67.52	0.86	1.3%
Integrative Activities	130.92	137.12	131.37	-5.75	-4.2%
Arctic Research Commission	1.19	1.17	1.45	0.28	23.9%
Total, Research and Related Activities	$4,234.82	$4,331.48	$4,665.95	$334.47	7.7%

Totals may not add due to rounding.

[1] OISE FY 2005 Actual includes $9.42 million provided to NSF by the U.S. Department of State for an award to the U.S. Civilian Research and Development Foundation.

FY 2007 Appropriations Language:

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; acquisition of aircraft; and authorized travel; ~~$4,387,520,000~~*$4,665,950,000*, to remain available until September 30, ~~2007~~*2008*, of which not to exceed ~~$425,000,000~~*$485,000,000* 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: Provided, ~~That from funds specified in the fiscal year 2006 budget request for icebreaking services, such sums shall be available for the procurement of polar icebreaking services: Provided further, That the National Science Foundation shall reimburse the Coast Guard according to the existing memorandum of agreement: Provided further,~~ 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~~: Provided further, That to the extent that the amount appropriated is less than the total amount authorized to be appropriated for included program activities, all amounts, including floors and ceilings, specified in the authorizing Act for those program activities or their subactivities shall be reduced proportionally: Provided further, That funds under this heading may be available for innovation inducement prizes]~~. *(Science Appropriations Act, 2006.)*

Research and Related Activities
FY 2007 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Rescission	Carryover/ Recoveries	Lapsed	Transfers[1]	Total Budgetary Resources	Obligations Incurred/ Estimated
FY 2005 Actual	4,254.59	-34.04	12.69	(0.78)	9.42	4,241.88	4,234.82
FY 2006 Current Plan	4,387.52	-56.04	7.06	-	-	4,338.54	4,338.54
FY 2007 Request	4,665.95	-	-		-	4,665.95	4,665.95
Change from FY 2006	$278.43					$327.41	

Totals may not add due to rounding.

[1]The U.S. Department of State transferred $9.42 million for an award to the U.S. Civilian Research and Development Foundation.

Explanation of Carryover:

Within the **Research and Related Activities** (R&RA) appropriation $7.06 million was carried forward into FY 2006. This includes $3.98 million carried forward by the Engineering Directorate as part of a competition to award a Nanoscale Science and Engineering Center (NSEC). The Foundation is in the process of negotiating a complex potential cooperative agreement as a result of this competition. The remaining R&RA carryover includes $2.36 million carried forward for efforts relating to Hurricane Katrina and $720,804 carried forward for the Office of Polar Programs (OPP).

RESEARCH AND RELATED ACTIVITIES
FY 2007 Performance Highlights

The table below shows the strategic planning and evaluation framework for activities funded through the Research and Related Activities (R&RA) appropriation. This framework was established in the NSF Strategic Plan for FY 2003-2008. NSF's strategic outcome goals are assessed annually by the Advisory Committee for GPRA Performance Assessment. The investment categories are assessed using the Program Assessment Rating Tool (PART). Additional information on these activities is available in the Performance Information section of this document.

Research and Related Activities
by Strategic Outcome Goal and Investment Category
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request
Fundamental Science and Engineering	$2,223.47	$2,222.82	$2,372.53
Centers Programs	236.67	253.25	259.78
Capability Enhancement	110.30	107.91	116.93
IDEAS	2,570.44	2,583.98	2,749.24
Facilities	326.85	323.44	348.98
Infrastructure and Instrumentation	446.27	464.38	549.78
Polar Tools, Facilities and Logistics	261.30	306.95	336.43
Federally-Funded R&D Centers	182.10	187.45	194.08
TOOLS	1,216.52	1,282.22	1,429.27
Individuals	347.15	325.44	339.87
Institutions	34.34	39.49	41.25
Collaborations	31.28	59.38	64.38
PEOPLE	412.77	424.31	445.50
ORGANIZATIONAL EXCELLENCE	35.08	40.97	41.94
Total, R&RA	$4,234.82	$4,331.48	$4,665.95

Totals may not add due to rounding.

NSF's 2007 Budget Request includes special initiatives within the R&RA Account.

- **Cyberinfrastructure**. Funding is requested for acquisition of a leadership-class, high performance computing (HPC) system. In acquiring such a system, NSF will work closely with other federal agencies similarly committed to the effective coordination of investments in HPC system acquisition and operation, including Department of Energy, NASA, DARPA, and other parts of the Department of Defense. This interagency partnership allows participating agencies to leverage expertise and promising practices, minimizes duplication of effort, and ultimately promises to increase the architectural diversity of leadership class systems available to researchers and educators around the country.

- **International Polar Year (IPY)**. NSF is requesting support for activities related to IPY. Research and education activities include Arctic environmental change, polar ice sheet dynamics and stability, and research on life in the cold and dark. Investments for infrastructure and logistics address a number of concerns, such as enabling winter research, equipping NOAA's Barrow Global Change Climate Research Facility, and increasing South Pole communications in support of physics and astronomy experiments.

- **Sensor Research**. Funds are requested to support leading edge research across NSF on sensors and in other areas that are potentially relevant to the detection of explosives and related threats. The Directorate for Engineering will lead this new NSF-wide effort which seeks to advance fundamental knowledge in new technologies for sensors and sensor networks, and in the use of sensor data in control and decision-making across a broad range of applications, particularly those that bear on the prediction and detection of explosive materials and related threats. NSF investments will coordinate with and leverage on research currently underway in other areas of the federal government such as the Department of Energy, U.S. Navy, and other parts of the Department of Defense.

In addition, as part of the 2007 budget process NSF completed Program Assessment Rating Tool (PART) reviews of two of its investment categories noted below. Both were rated effective.

- **Fundamental Science and Engineering (FSE)**. This is the Foundation's largest investment category. It comprises the core set of research activities that ensure the vitality of a broad array of scientific and engineering fields needed for the U.S. to maintain science and engineering leadership.

- **Federally Funded Research and Development Centers (FFRDCs)**. These support 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. NSF's FFRDCs are uniquely positioned to provide capabilities and state-of-the-art instrumentation. The five designated FFRDCs are the National Astronomy and Ionosphere Center, National Center for Atmospheric Research, National Optical Astronomy Observatory/National Solar Observatory, National Radio Astronomy Observatory, and Science and Technology Policy Institute.

BIOLOGICAL SCIENCES $607,850,000

The FY 2007 Budget Request for the Directorate for Biological Sciences (BIO) is $607.85 million, an increase of $31.16 million, or 5.4 percent, over the FY 2006 Current Plan of $576.69 million.

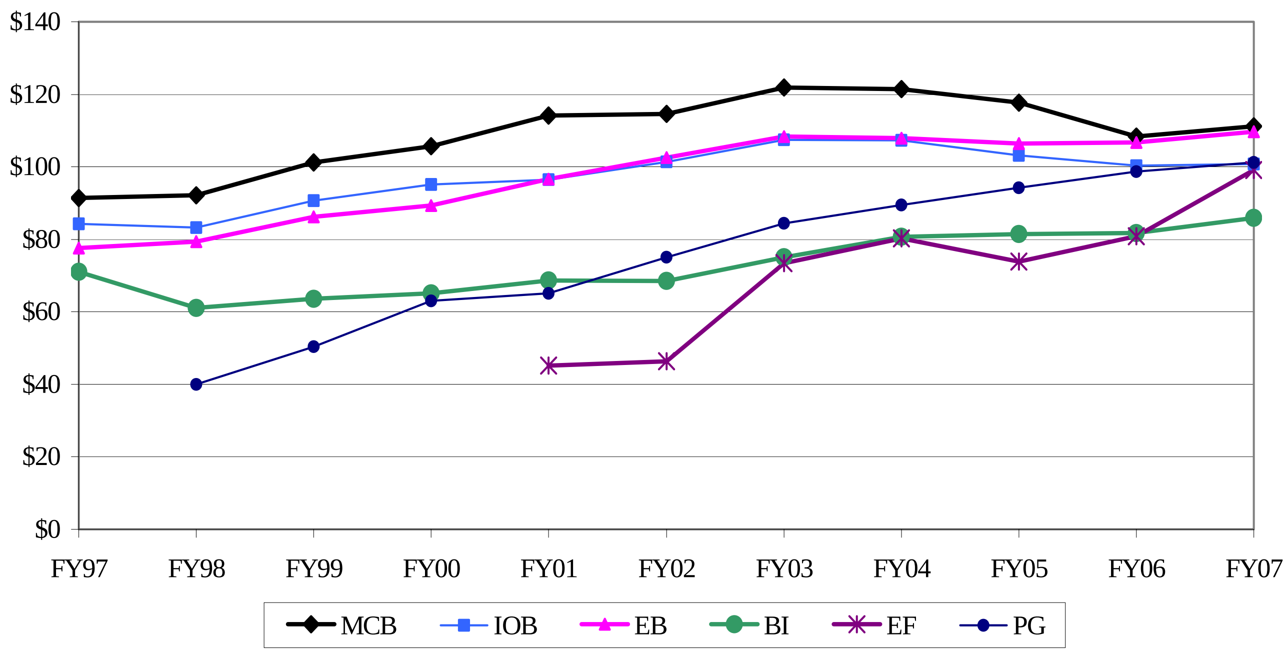
Biological Sciences Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Molecular and Cellular Biosciences (MCB)	$117.74	$108.27	$111.22	$2.95	2.7%
Integrative Organismal Biology (IOB)	103.12	100.39	100.74	0.35	0.3%
Environmental Biology (EB)	106.47	106.71	109.61	2.90	2.7%
Biological Infrastructure (BI)	81.41	81.80	85.90	4.10	5.0%
Emerging Frontiers (EF)	73.80	80.80	99.16	18.36	22.7%
Plant Genome (PG)	94.24	98.72	101.22	2.50	2.5%
Total, BIO	$576.78	$576.69	$607.85	$31.16	5.4%

Totals may not add due to rounding.

The Directorate for Biological Sciences (BIO) supports research, infrastructure, and education in the biological sciences at U.S. colleges, universities, non-profit research institutions, and other research and education organizations such as museums and independent field stations.

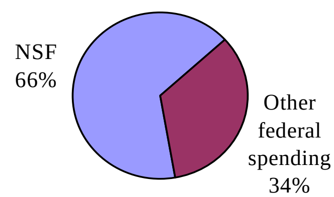
BIO Subactivity Funding
(Dollars in Millions)



RELEVANCE

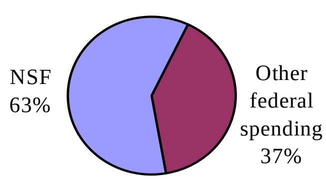
Advancing fundamental scientific discovery in all aspects of life – from molecules to whole ecosystems – is supported within NSF, where the ability to integrate the range of biological sub-disciplines is unique. Of the non-medical aspects of the biological sciences, BIO is the dominant federal supporter of basic research at academic institutions – providing 66 percent of all support. Issues of national importance related to the environment, economy, agriculture, and human welfare require an understanding of how living organisms function and interact with non-living systems. BIO-supported research enhances this understanding. NSF's contribution to a broad array of the biological sciences is critically important – particularly in such areas as environmental biology and plant sciences.

Federal Support for Basic Research in Non-Medical Biological Sciences at Academic Institutions



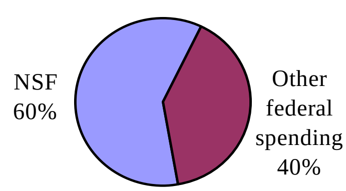
BIO support represents 63 percent of all federal funding for basic research in environmental biology. For example, the Assembling the Tree of Life program supports large teams of scientists working across institutions and disciplines to assemble a phylogeny, a genealogical map for all 1.7 million described species on Earth. Through its Long-Term Ecological Research program, BIO supports researchers creating well-designed and documented ecological experiments that can provide information needed for answering basic ecological questions. Additionally, BIO is the principal source of federal support for enhancing biological specimen collections and for modernizing facilities and equipment at biological field stations and marine laboratories.

Federal Support for Basic Research in Environmental Biology at Academic Institutions



BIO provides an estimated 60 percent of federal support for plant biology at academic institutions. The Plant Genome Research program supports projects that make significant contributions to our understanding of plant genome structure and function. 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. Since the program's inception in FY 1998, accomplishments have included the sequencing of the whole genomes of rice and *Arabidopsis thaliana*; continued discovery of new genes involved in plant processes of economic value including disease resistance, stress tolerance, and floral development; and the establishment of several databases where plant genome data are presented in an integrated and cross-referenced form.

Federal Support for Basic Research in Plant Biology at Academic Institutions



Summary of Major Changes by Division	*(Dollars in Millions)*
BIO FY 2006 Current Plan ……………………………………………………………	**$576.69**

Molecular and Cellular Biosciences (MCB) $2.95

Support for microbial biology including observatories, analysis of living networks and complex interacting processes, integrated research in nanobiology, and plant biology will be emphasized.

Integrative Organismal Biology (IOB) $0.35

Disciplinary and interdisciplinary research in the IOB core will increase by $4.18 million, which includes an increase of $0.35 million plus an additional $3.83 million due to the transfer of responsibility for funding the Science and Technology Center for Behavioral Neuroscience from IOB to Emerging Frontiers.

Environmental Biology (DEB) $2.90

Disciplinary and interdisciplinary research in the DEB core will increase by $6.32 million, which includes an increase of $2.90 million plus an additional $3.42 million due to the transfer of responsibility for funding the National Center for Ecological Analysis and Synthesis from DEB to Emerging Frontiers.

Biological Infrastructure (DBI) $4.10

Research Resources: An increase of $2.55 million will enhance support for cyberinfrastructure in biology, including databases. Support for the multi-user instrumentation programs, put on hold in FY 2006, will continue to be deferred for FY 2007.

Human Resources: An increase of $1.55 million will be used to enhance support for programs that broaden participation and for NSF's K-12 education portfolio.

Emerging Frontiers (EF) $18.36

Redirection of funds from other programs within EF will allow for increased support for the Frontiers in Integrative Biological Research (FIBR) program and initiation of a new program in theoretical biology. BIO will begin a collaboration with SBE on Biology and Society. Support for centers will be centralized within EF to foster collaboration and integration of research themes. As enormous amounts of genomic data, including data generated from plant research, have flooded cyberspace, the need for additional analysis and synthesis centers with a focus on genomics data will be considered within budgetary constraints. (+$8.36 million)

NEON: An increase will enhance R&D efforts in sensor development. (+$6.0 million)

Activities to broaden participation of individuals from underrepresented groups will be increased through programs such as Research Initiation Grants and Career Advancement Awards to Broaden Participation in the Biological Sciences (RIG/CAA). (+$4.0 million)

Plant Genome Research Program (PGR) $2.50

Genome-enabled plant biology research that takes advantage of cyberinfrastructure and the latest systems biology will receive the highest priority. Some support will also be provided for the BIO-wide Arabidopsis '2010' project. The interagency maize genome-sequencing project begun in FY 2005 will continue.

Subtotal, Changes +$31.16

BIO FY 2007 Request ………………………………………………………………...…….$607.85

Summary of Major Changes by Directorate-wide Investments *(Dollars in Millions)*

BIO FY 2006 Current Plan ……………………………………………………………………….$576.69

Advancing the Frontier +$18.06

Disciplinary and interdisciplinary research in core BIO programs will increase by $12.82 million. The number of awards will increase by about 95; the funding rate, currently below the 20 percent level, will remain low at 18 percent. As part of this increase, support for Frontiers in Biological Research (FIBR), along with a program to foster development in theoretical biology will be increased by $8.63 million. FIBR projects are multidisciplinary and address complex biological systems.

NSF has supported Long-Term Ecological Research (LTER) for over 20 years. Following the recommendations of a two-year strategic planning process, additional investments in cyberinfrastructure have been proposed to facilitate cross-site collaborations (+$1.15 million).

Centers

Support for all BIO centers including Science & Technology Centers will be centralized within Emerging Frontiers, and funding will increase by $4.09 million. The Center for Microbial Oceanography at the University of Hawaii was selected in the FY 2005 STC competition. Initial FY 2006 funding is through Integrative Activities; FY 2007 funding is through BIO.

Priority Areas

Biocomplexity in the Environment (BE) and Mathematical Sciences (MS) priority areas will continue their phase-downs, transferring $22.10 million into base programs where these emphases will continue.

Broadening Participation in the S&E Enterprise +$4.00

Research Initiation Grants and Career Advancement Awards (RIG/CAA) seek to promote the development and retention of scientists from underrepresented groups and to increase the numbers of such individuals that serve as role models for the scientific workforce of the future. Funding for RIG/CAA and programs with similar goals will increase by $4.0 million.

Education and Workforce +$0.55

BIO will increase support for the GK-12 program by $550,000, for a total of $1.69 million.

<u>Facilities and Infrastructure</u>

+$6.00

R&D for NEON, a terrestrial research platform that will advance basic ecological understanding while contributing to the goals of the *US Strategic Plan for an Integrated Earth Observation System* (IEOS), will increase by $6.0 million for a total of $11.94 million. Increased investments include sensor development and cyberinfrastructure, including test-beds for connectivity between field deployed instruments, are necessary to keep NEON project planning on schedule.

+$2.55

Research Resources: An increase of $2.55 million will enhance support for cyberinfrastructure, including databases, in biology.

Subtotal, Changes +$31.16

BIO FY 2007 Request …………………………………………………………………..…$607.85

NSF-WIDE INVESTMENTS

BIO NSF-wide Investments
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biocomplexity in the Environment	$39.86	$30.43	$9.43	-$21.00	-69.0%
Climate Change Science Program	15.10	15.10	15.10	-	-
Cyberinfrastructure	77.00	84.00	90.50	6.50	7.7%
Human and Social Dynamics	0.50	0.50	0.50	-	-
International Polar Year	-	-	2.00	2.00	N/A
Mathematical Sciences	2.21	2.21	1.11	-1.10	-49.8%
National Nanotechnology Initiative	46.78	49.00	52.55	3.55	7.2%
Networking and Information Technology R&D	77.00	77.00	83.50	6.50	8.4%

In FY 2007, the BIO directorate will support research and education efforts related to broad, Foundation-wide investments in a number of areas, including NSF's multidisciplinary priority areas and the Administration's interagency R&D priorities.

Biocomplexity in the Environment: Funding will continue for environmental genomics, including a new activity in support of the International Polar Year (IPY) – Life in the Cold and Dark. Support for the Ecology of Infectious Diseases and Microbial Genome Sequencing research programs that contribute to Homeland Security R&D goals, while no longer components of BE, will be sustained at $21.0 million and managed in the Emerging Frontiers subactivity.

Climate Change Science Program: A total of $15.10 million will continue support for research to address key aspects of land use and land-cover change through studies on ecological rates of change and related loss of species diversity. This includes support for programs that specifically address terrestrial ecosystem response to climate change through experimental, modeling, and laboratory studies, including research in the Long Term Ecological Research (LTER) program.

Cyberinfrastructure: A total of $90.5 million (+$6.50 million) includes support for databases and informatics tools within BIO, including support for the Protein Data Bank (PDB), the international repository and primary source for information about the structure of biological macromolecules, and TAIR, The *Arabidopsis* Information Resource. Increased support in FY 2007 will focus on the cyberinfrastructure needs of long term ecological research, biological databases and other informatics tools, and test-beds for connectivity between field deployed instruments, including sensors and data collection necessary for the final deployment of NEON.

Human and Social Dynamics: A total of $500,000 will be provided to support a focus on modeling human and social dynamics that are related to biological systems.

International Polar Year: As part of the International Polar Year (2007-2008), BIO will provide $2.0 million to support research that addresses scientific challenges such as biological adaptation and ecosystem dynamics in polar environments using genomics tools. A new program activity, "Life in the Cold and Dark," will be developed as part of the IPY.

Mathematical Sciences: As this priority area continues its phase-down, a total of $1.11 million will continue support for interdisciplinary research training at the intersection of the mathematical and biological sciences. This program aims to transcend traditional boundaries in educating biological and mathematical scientists, so as to strengthen the nation's research enterprise at this critical interface.

National Nanotechnology Initiative: A total of $52.55 million (+$3.55 million) will continue support for biosytems at the nanoscale, to support study of biologically-based systems that exhibit novel properties and potential applications. Potential applications are derived from exploiting functions of cellular organelles, devices for research in genomics, proteomics and cell biology, and nanoscale sensory systems. Special emphasis will be placed on research involving interdisciplinary research teams in FY 2007.

Networking and Information Technology R&D: A total of $83.5 million (+$6.50 million) will continue support for Human-Computer Interaction and Information Management (HCI&IM) to increase the benefit of computer technologies to biology; and for Software Design and Productivity (SDP) leading to fundamental advances in concepts, methods, techniques, and tools for software design.

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 98 percent in FY 2005, 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, which are composed of qualified external evaluators who 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 NSF's investments.

The Directorate for Biological Sciences 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 from academic institutions and industry represent a cross section of biology. The Committee is balanced with respect to gender, underrepresented minorities, and geographic regions.

PERFORMANCE

NSF's FY 2007 Budget Request is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals and the ten investment categories highlighted in the FY 2003-2008 Strategic Plan. These categories were designed to better enable assessment of program performance and to facilitate budget and performance integration.

Biological Sciences

By Strategic Outcome Goal and Investment Category

(Dollars in Millions)

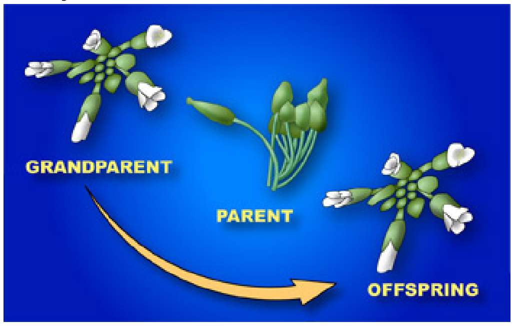
	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Ideas					
Fundamental Science and Engineering	400.85	383.30	397.27	13.97	3.6%
Centers Programs	11.07	10.22	14.31	4.09	40.0%
Capability Enhancement	-	-	-	-	N/A
	411.92	393.52	411.58	18.06	4.6%
Tools					
Facilities	7.18	7.13	13.13	6.00	84.2%
Infrastructure and Instrumentation	88.69	109.11	111.66	2.55	2.3%
Polar Tools, Facilities and Logistics	-	-	-	-	N/A
Federally-Funded R&D Centers	-	-	-	-	N/A
	95.87	116.24	124.79	8.55	7.4%
People					N/A
Individuals	61.20	59.24	63.79	4.55	7.7%
Institutions	2.72	2.69	2.69	-	-
Collaborations	-	-	-	-	N/A
	63.92	61.93	66.48	4.55	7.3%
Organizational Excellence	5.07	5.00	5.00	-	-
Total, BIO	$576.78	$576.69	$607.85	$31.16	5.4%

Totals may not add due to rounding.

BIO will continue its commitment to education, training, and increasing diversity while emphasizing 21st Century Biology within all of its divisions and subactivities. The FY 2007 budget will slightly increase award size and continue to focus on multidisciplinary research activities, interagency partnerships, and international activities, with special attention given to broadening participation at all levels.

Recent Research Highlights

► **Reappearance of Missing Genetic Information Poses Exception to the Rule** For more than a century, the laws of inheritance dictated that genetic information contained in the nuclear genome is passed from one generation to the next in a predictable manner: from grandparents to parents to children. Recently, researchers at Purdue University have shown this cardinal rule is sometimes broken. By examining the genome of the model plant, *Arabidopsis thaliana*, they found genetic information absent in the parent would unexpectedly reappear in the genome of their offspring. They postulate that this "hidden" genetic information is maintained outside of the nuclear genome for numerous generations. Under certain circumstances these “hidden” sequences can be reincorporated and restore genomic sequences back to an ancestral state.

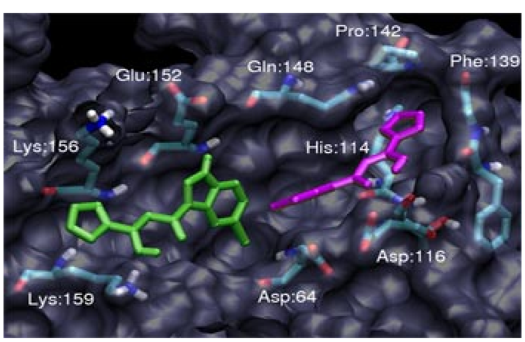


Researchers discovered "missing" genetic information could reappear in later generations.

► **ORNIS: Five Million Birds in Your Computer** With over 70 million amateur and professional ornithologists, bird watching remains one of the most popular outdoor activities in the United States. ORNIS (ORNithological Information System), an NSF-sponsored information network developed at the University of Kansas, links together 33 ornithology collections from the U.S., Canada and Mexico into one “virtual” museum (http://ornisnet.org/) that allows users to extract information on nearly five million bird specimens. ted. The information identifies places where living birds are found and habitats that might be suited for recolonization. ORNIS linked to similar information networks for other animal groups will create a biodiversity knowledge resource for tracking climate change and emerging diseases, like West Nile Virus.

ORNIS currently includes 33 North American bird collections, marked on this map with red dots.

► **Molecules in Motion: Computer Simulations Increase Understanding of Protein Structures**. Andrew McCammon’s work at the San Diego Supercomputer Center (SDSC) has been key in the design of a new class of drugs for the treatment of human immunodeficiency virus (HIV). McCammon and colleagues are harnessing the power of the supercomputer to understand the structure and function of molecules inside cells and to predict how the molecules might react to new drugs before any experiments are conducted in the laboratory. McCammon recently elucidated the structure of a crucial HIV protein allowing researchers at Merck Pharmaceutical Company to design new drugs targeting the protein. The drugs are now entering human clinical trials.



► **Scientists Reveal Aerodynamics of Tiny Bird's Flight** Hummingbirds are unique among birds for their ability to hover for long periods of time. Using a sophisticated digital imaging technique, researchers from Oregon State University, University of Portland and George Fox University have determined the aerodynamics of hummingbird flight. The team found that hummingbirds support 75 percent of their weight during the wing's down stroke and 25 percent on the up stroke. This contrasts with other birds, which use the down stroke to support 100 percent of their weight during slow flight and short-term hovering. The finding provides new insight into evolutionary trends that led to sustained hovering in birds and may provide engineers with a new model for future miniature autonomous flying vehicles.

Scientists used computer-aided digital imagery to analyze the aerodynamics of rufous hummingbird hovering.

► **Yellowstone Discovery Bodes Well for Finding Evidence of Life on Mars** Researchers from the University of Colorado have discovered microbes in the pores of rocks in a highly acidic environment in Yellowstone's Norris Geyser Basin. The most abundant microbes identified by the team were a new species of mycobacterium, a group best known for causing tuberculosis and leprosy. The scientists also found that rock formation processes in the Norris Geyser Basin created fossil imprints of the organisms at various stages, leaving a record of development over time. They believe similar kinds of geothermal environments may have existed on Mars, where astrobiologists have intensified the search for past and present life forms in recent years. Thus, these bizarre microbes found in Yellowstone can provide new clues about ancient life on Earth and help steer the hunt for evidence of life on Mars.

► **Arkansas University Recruits Minority Scientists for Environmental Research** Mentorship is alive and well at Arkansas State University, where geochemist Robyn Hannigan has established a program to immerse minority and female students in the study of environmental science. The result has been a double success for science and education. The program, Research Internships in Science of the Environment (RISE), gives some students their first experience doing research. A Native American from a disadvantaged community, Hannigan knows from experience that science only appeals to many students after they have personally conducted hands-on research. With funding from NSF's Research Experiences for Undergraduates program, Hannigan designed RISE to increase diversity in the scientific workforce. Since 2001, RISE has supported the summer research projects of more than 30 undergraduate students. RISE participants work across disciplines to focus on the relationships between agricultural land use and ecological health. So far, Hannigan reports, more than 90 percent of graduates from the RISE program have gone on to pursue a doctorate.

Other Performance Indicators

The tables below show the change in the number of people benefiting from BIO funding along with trends in the award size, duration and number of awards.

Number of People Involved in BIO Activities

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Senior Researchers	3,554	3,554	3,800
Other Professionals	1,598	1,598	1,710
Postdoctorates	1,360	1,360	1,455
Graduate Students	2,066	2,066	2,210
Undergraduate Students	2,291	2,291	2,450
K-12 Teachers	20	20	25
Total Number of People	10,889	10,889	11,650

BIO Funding Profile

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Statistics for Competitive Awards:			
Number	1,355	1,355	1,450
Funding Rate	21%	21%	22%
Statistics for Research Grants:			
Number of Research Grants	923	923	986
Funding Rate	17%	17%	18%
Median Annualized Award Size	$140,000	$140,000	$147,000
Average Annualized Award Size	$184,040	$184,040	$193,200
Average Award Duration, in years	3	3	3

MOLECULAR AND CELLULAR BIOSCIENCES $111,220,000

The FY 2007 Budget Request for the Division of Molecular and Cellular Biosciences (MCB) is $111.22 million, an increase of $2.95 million, or 2.73 percent, over the FY 2006 Current Plan of $108.27 million.

Molecular and Cellular Biosciences Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Molecular and Cellular Biology	**$117.74**	**$108.27**	**$111.22**	**$2.95**	**2.7%**
Major Components:					
Research & Education Projects	117.74	108.27	111.22	2.95	2.7%

About MCB:

MCB supports innovative research on the fundamental properties and dynamics of the molecular and cellular basis of life. This research advances our understanding of multi-scale, complex biological systems and their interactions with the physical world. Innovative ideas and insights from MCB investigators transform our understanding of the natural world, contribute to our economy through new applications in biotechnology, agriculture and the environment, and provide new insights that contribute to our ability to detect and defend against biological threats.

Transformative studies of complex biological questions increasingly require the tools of genomics, computer and information science, the physical sciences, and mathematics to achieve insights into the nature and function of the molecular machinery of the living cell, the mechanisms by which genetic information is transmitted and expressed, and the processes by which living cells are organized, communicate, and respond to environmental signals. MCB continues to forge partnerships with complementary disciplines to support research at these interfaces, to introduce new analytical and conceptual tools for biological research, and to provide unique education and training environments for the next generation of versatile biologists and scientifically literate citizens.

The Molecular and Cellular Biosciences Division is organized into three clusters: *Biomolecular Systems*, *Cellular Systems*, and *Genes and Genome Systems*. Multidisciplinary research is supported in each of these areas. *The Biomolecular Systems* cluster includes the scientific themes of molecular biochemistry, biophysics, and metabolic pathways and networks. The use of cutting-edge technologies is a priority to integrate theoretical, computational, and experimental approaches to study individual biological molecules and their functional complexes (representing paradigms for nanomachines). *The Cellular Systems* cluster supports research that addresses questions about how living cells are organized, how they communicate, and how they respond to internal and external signals. Areas supported include nanoscale studies of the structure, function, and assembly of cellular elements. Cellular mechanisms underlying immune-like defense mechanisms in plants and diverse animals, particularly lower vertebrates and invertebrates, are also a priority. *The Genes and Genome Systems* cluster supports studies of genomes and genetic mechanisms in all types of organisms. Areas of interest include genome organization, replication, recombination, repair, and vertical and lateral transmission of heritable information, as well as study of the processes that carry out and regulate expression of the information encoded in the genome.

In general, 40 percent of the MCB portfolio is available for new awards. The remaining 60 percent will fund awards made in previous years.

MCB priorities for FY 2007:

Integration of education and training and broadening participation in all aspects of molecular and cellular research. These priorities make available to the U.S. scientific enterprise the human and intellectual resources represented by all areas of the country, all types of institutions of higher education, and all facets of U.S. society, including those that until now have not been fully involved.

Research and education at the interface of biology and the physical sciences: In partnership with the Directorate for Mathematics and Physical Sciences, MCB will continue to support beginning investigators whose pioneering projects integrate research and education.

Living Networks and Complex Processes: There is growing appreciation that the functions of living cells cannot be understood as a collection of individual, linear processes, but only when viewed as interacting and interdependent networks. MCB will give priority to theoretical, computational, mathematical modeling and simulation approaches in all areas of the molecular and cellular biosciences. Formulating and testing physical and mathematical models of the structure and function of living networks of complex molecules, metabolic pathways, and other exquisitely regulated cellular processes represents one of the greatest theoretical and computational challenges facing biology in the 21^{st} century. Cyberinfrastructure is indispensable for capturing and analyzing genome data to mathematically simulate complex networks of cellular signaling events.

Microbial Biology: MCB, through its core activities, encourages research on microbes at all levels of biological organization. New genomic and biochemical approaches are used to identify and characterize basic attributes of microbes, most of which are newly described. Understanding previously unknown microbes and their complex interactions with one another, with other organisms, and with the physical environment, is needed to develop integrated models. MCB supports this research through the microbial observatories and microbial interactions and processes efforts. These efforts contribute to "The Microbe Project," a coordinated interagency effort.

Plant biology: Unsolicited research supported by MCB led to the discovery of the value of *Arabidopsis thaliana* as a model flowering plant. A high priority will be the continued support of broad-based plant biology research, particularly research enabled by the availability of the complete genome sequence of *Arabidopsis* and resources developed through the Arabidopsis 2010 project and the Plant Genome Research program.

Changes from FY 2006:

- Disciplinary and interdisciplinary research in the MCB core will increase by $2.95 million. However, this increase is accompanied by a resumption of responsibility for microbial observatories and microbial interactions and processes research.

INTEGRATIVE ORGANISMAL BIOLOGY $100,740,000

The FY 2007 Budget Request for the Division of Integrative Organismal Biology (IOB) is $100.74 million, an increase of $0.35 million, or 0.3 percent, over the FY 2006 Current Plan of $100.39 million.

Integrative Organismal Biology Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Integrative Organismal Biology	**$103.12**	**$100.39**	**$100.74**	**$0.35**	**0.3%**
Major Components:					
Research & Education Projects	99.17	96.56	100.74	4.18	4.3%
Centers					
STC for Behavioral Neuroscience	3.95	3.83	-	-3.83	-100.0%

About IOB:

Biology, in the context of the organism, addresses questions that cannot be answered by focusing on the extremes of molecules or the environment. Richard Feynman, the oft-quoted recipient of the 1965 Nobel Prize in Physics, noted: *You can know the name of a bird in all the languages of the world, but when you're finished, you'll know absolutely nothing whatever about the bird.* Innovations in genomics, molecular biology, and computer science are now enabling advancement of the frontiers of knowledge on previously bewilderingly complex questions such as how does a bird fly, a heart beat, a flower bloom, or a sea urchin evolve. Research supported by IOB focuses on questions such as these, in order to understand the structure and function of organisms, with particular emphasis on the mechanisms by which organisms develop, behave, and respond to their environment.

Understanding organisms requires innovative integration of information across levels of analysis and stages of development, across phyla, environments, and evolutionary time. It can also require computational techniques and interdisciplinary perspectives from other areas of biology, the physical sciences, mathematics, engineering, social sciences and computer science. An underlying theme is the use of a wide diversity of organisms to identify unifying principles common to all organisms, and to understand the variety of adaptive mechanisms that have evolved in specific organisms.

The essence of organismal biology lies in the dynamics of living systems that cannot be described merely by enumerating their components. IOB researchers are now advancing the frontier of understanding complex, dynamic biological organisms in their native environments by building on investments in genome sequencing and projects that have accumulated in-depth knowledge of the molecular nature of biological systems. These innovative studies offer potential solutions to many critical national problems, such as energy production, carbon sequestration, and environmental cleanup. A better understanding of organismal biology will lead to improved diagnosis and treatment of disease, as well as better protection of people from environmental hazards. It will allow creation of novel biochemical processes and the modification of organisms to achieve predictable results. For example, organisms could be modified to serve as sensitive detectors for dangerous pathogens and toxins, or to create novel materials, catalysts, and drugs.

In general, 45 percent of the IOB portfolio is available for new awards. The remaining 55 percent will fund awards made in previous years.

IOB Priorities for FY 2007:
IOB will place highest priority on integrative studies that lead to a deeper understanding of the underlying principles, mechanisms, and processes that determine the behavior, development, physiology and adaptations of organisms. Studies that cross previously disparate scientific areas and that cross scales of organization from molecules to phenotypes and behavior will be highlighted. Highest priority will be placed on the following areas:

Integrative Developmental Biology: Developmental biologists have, for many years, focused their efforts to understand development by studying a few "model" organisms at the genetic, molecular and cellular levels. These efforts have led to a detailed understanding of underlying genetic mechanisms that control developmental events. Animal physiologists, by contrast, have employed a broad array of study systems, each selected for its unique suitability to address a specific physiological mechanism. But a deeper understanding of the development and function of living organisms will require integration of the approaches of each of these fields. This is not just an issue of filling in gaps that have been neglected (although these do exist), but more importantly of synthesizing the conceptual approaches, methodologies, and analytical tools of the two disciplines. Molecular-genetic approaches to development are well suited to uncovering details of cellular regulatory mechanisms, but they are typically not suited to elucidate mechanisms that operate at the level of tissues, organs and whole animals. Physiological approaches, by contrast, can elucidate higher-level regulatory mechanisms but are traditionally non-genetic. Both approaches are advanced by an increasingly powerful array of genomic techniques that provide outstanding opportunities to address important issues of long-standing interest to both physiologists and developmental biologists.

Genetic/Cellular Basis for Behavior: Behavior is the fundamental interface of an organism with its environment and with other individuals. While complex behaviors such as foraging, mate selection, or parental care are still poorly understood from a genetic point of view, advances in genetic tools, methods and databases, including those from whole-genome sequence projects, are providing unprecedented resources for genomic analyses of complex traits. These developments are providing new tools easily adopted for studying complex behavior, not only in model species but also in non-model organisms. The integration of the ability to identify the activity of individual genes active in specific neurons, with the ability to identify and examine neural networks in a variety of organisms will allow the focusing of research on the genetic/cellular basis for behavior. The ultimate goal is to understand the genetic basis of behavioral complexity and to develop an understanding of the principles underlying the genetic basis of behavioral diversity.

Changes from FY 2006:

- Disciplinary and interdisciplinary research in the IOB core will increase by $4.18 million, which includes an increase of $0.35 million plus an additional $3.83 million due to the transfer of responsibility for funding the Behavioral Neuroscience Science and Technology Center to Emerging Frontiers. Additional IOB funds will increase support for the areas of Integrative Developmental Biology and Genetic/Cellular Basis for Behavior.

ENVIRONMENTAL BIOLOGY $109,610,000

The FY 2007 Budget Request for the Division of Environmental Biology (DEB) is $109.61 million, an increase of $2.90 million, or 2.72 percent, over the FY 2006 Current Plan of $106.71 million.

Environmental Biology Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Environmental Biology	**$106.47**	**$106.71**	**$109.61**	**$2.90**	**2.7%**
Major Components:					
Research & Education Projects	103.00	103.29	109.61	6.32	6.1%
Centers Program					
National Center for Ecological Analysis and Synthesis	3.47	3.42	-	-3.42	-100.0%

About DEB:

The Division of Environmental Biology supports catalytic and transformative research to inventory life on earth, to discover life's origins and evolutionary history, and to understand the dynamics of ecological systems. Ecological systems, in turn, provide goods and services upon which human health and welfare depend (e.g., breathable air, potable water, food and fiber, crop pollination, disease control). Two fundamental theories define the frontiers of inquiry for environmental biology: the theory that all forms of life evolve by natural selection or genetic drift; and the theory that all life is connected to form functional ecosystems.

DEB will continue to balance disciplinary and transdisciplinary research needs; focus on science that NSF supports uniquely, or especially well; enhance ecological and evolutionary synthesis; and educate the next generation of environmental biologists while promoting full participation of all groups. Four clusters represent the major areas of scientific focus in DEB. Studies supported within and across these clusters accelerate the rate of discovery of new species, address the genealogical relationships of plants, animals, fungi, and microbes; elucidate the spatial and temporal dynamics of species interactions (e.g., competition, predation); discover the principles or rules by which species are assembled into functional communities and change through time; and determine the flux of energy and materials through ecosystems.

In addition, the Long-Term Ecological Research (LTER) program is a network of 26 comprehensive research sites located in areas broadly representative of the global range of natural, agricultural and urban ecosystems. A Network Office coordinates information and cross-site communication, as well as education, outreach and international activities, while promoting synthesis via an open access data policy. All LTER projects share common research themes that facilitate multi-site comparisons and encourage interdisciplinary activities.

In general, 45 percent of the DEB portfolio is available for new awards. The remaining 55 percent will fund awards made in previous years.

DEB priorities for FY 2007:

Advancing the Frontier: One of the grand challenges for environmental biology in the 21st century is to discover and comprehend the ecological and evolutionary mechanisms that maintain the structure and functioning of ecosystems, in light of anthropogenic and natural change. This requires a research enterprise that focuses an intellectual critical mass on a cascade of questions that connect our understanding of the biosphere to the services provided to humans by nature. In FY 2007, DEB will respond to this challenge by supporting: theory development that can be used to guide this research; projects that address the couplings of systems across different time and space scales; the dynamics of, and feedbacks between, human and natural systems; and the couplings of evolutionary and ecological mechanisms.

A second compelling challenge is to inventory the diversity of life on the planet, and to place this information in the context of a predictive understanding of the tree of life. In FY 2007, DEB will support an increased level of biodiversity inventory research, selecting projects that are cast within the theoretical framework of the tree of life.

Cyberinfrastructure: Special emphasis will be given to leveraging new cyberinfrastructure capabilities, developing partnerships with the informatics and computer sciences community, and bringing innovative analytical tools into the arsenal of environmental biologists. These investments arise from the initial support of the Information Technology Research program, and are particularly evident in the LTER network.

Education and Broadening Access: DEB will continue to place a premium on outstanding educational activities that are coupled to research projects. Support will emphasize broad career horizons, experiential learning, and preparing people to understand and apply information about the biological world in their daily lives. Support for CAREER grants, Doctoral Dissertation Improvement Grants, and Research Experiences for Undergraduates will be maintained. We will maintain funding for the LTER Schoolyard Science activity to enhance engagement of students in the primary and secondary schools.

Changes from FY 2006:

- Disciplinary and transdisciplinary research in the DEB core will increase by $6.32 million. Of this amount, $3.42 million comes from the transfer of responsibility for funding the National Center for Ecological Analysis and Synthesis to Emerging Frontiers.

- Support for the LTER Program will be increased by $1.15 million to a total of $19.61 million, in FY 2007. Additional funds will augment support for site-based integrated research and educational activities, cross-site collaborations, and continued development of cyberinfrastructure capabilities.

BIOLOGICAL INFRASTRUCTURE $85,900,000

The FY 2007 Budget Request for the Division of Biological Infrastructure (DBI) is $85.90 million, an increase of $4.10 million, or 5.01 percent, over the FY 2006 Current Plan of $81.80 million.

Biological Infrastructure Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Research Resources	$49.98	$51.03	$53.58	$2.55	5.0%
Human Resources	$31.43	$30.77	$32.32	$1.55	5.0%
Biological Infrastructure	**$81.41**	**$81.80**	**$85.90**	**$4.10**	**5.0%**
Major Components:					
Research & Education Projects	74.23	74.66	78.76	4.10	5.5%
Facilities					
National Nanotechnology Infrastructure Network	0.40	0.40	0.40	-	-
National Ecological Observatories Network	5.98	5.94	5.94	-	-
Cornell High Energy Synchrotron Source	0.80	0.80	0.80	-	-

About DBI:

DBI's responsibility is to build and develop innovative scientific infrastructure that empowers the biological research community to advance all fields of biology.

DBI is organized into two clusters. The Research Resources cluster supports development of research tools and resources, such as:

- Informatics tools – to provide power to mine all available information;
- Research resources – to develop database/knowledgebase biological resources to be mined for new insights and discoveries; and
- Instrumentation – to provide access to the latest instrumentation and to develop instrumentation with new capabilities.

In addition, this cluster supports planning for the proposed National Ecological Observatories Network, and research resource development for the BIO-wide *Arabidopsis* 2010 project. The Human Resources cluster supports education activities with the goal of training a new generation of scientists who are open to new and different approaches and ideas across all boundaries ("fearless scientists").

In general, 52 percent of the DBI portfolio is available for new awards. The remaining 48 percent will fund awards made in previous years.

DBI Priorities for FY 2007:
Cyberinfrastructure has been an integral part of all DBI programs and will be a highest priority for FY 2007.

Research Resources

- Instrumentation Resources: DBI supports three instrumentation programs: (1) Instrument Development for Biological Research (IDBR); (2) Multi-User Equipment (MUE) for biological research; and (3) improvement of Field Stations and Marine Laboratories (FSML). IDBR and FSML will be maintained at FY 2006 levels. MUE was suspended in FY 2006
- Biological Databases and Informatics (BD&I): BD&I supports the design, development, implementation, and use of information resources and tools.
- Biological Research Collections (BRC): BRC supports natural history collections archived at museums, botanical gardens, field stations, and academic institutions that are widely used for biological research and education. DBI will place a priority on networking collection databases.
- Living Stock Collections (LSC): LSC supports repositories of research organisms, genetic stocks, seeds, cell lines and DNA clones that are associated with whole organisms in a collection.
- *Arabidopsis* 2010 Project: The *Arabidopsis* 2010 Project is a BIO-wide activity whose goal is to determine the function of all Arabidopsis genes by 2010. DBI supports 2010 projects that build community research resources, such as collections of full-length cDNA clones and a large collection of insertion mutants. Data and information from the *Arabidopsis* 2010 awards are deposited into The *Arabidopsis* Information Resources (TAIR).
- National Ecological Observatories Network (NEON): Implementation planning continues for NEON, a continental-scale research instrument consisting of geographically distributed infrastructure, networked via state-of-the-art communications.

Human Resources

- Postdoctoral Research Fellowships: In FY 2007, BIO will support Minority Postdoctoral Research Fellowships.
- Undergraduate Mentoring in Environmental Biology (UMEB): UMEB supports 5-year projects designed to engage undergraduates, especially from underrepresented groups, in year-round research and sustained mentoring activities. This program will not be offered in FY 2007.
- Cross-disciplinary Research at Undergraduate Institutions (C-RUI): This program for predominantly undergraduate institutions supports cross-disciplinary research. C-RUI is offered in alternate years from UMEB, and will be competed in FY 2007.
- Research Experience for Undergraduates (REU) sites: Support for REU sites continues to be a high priority. Broadening participation will continue to be a priority in FY 2007.

Changes from FY 2006:

- Research Resources will increase by $2.55 million, of which $780,000 will be used specifically to support cyberinfrastructure activities. The rest will support high priority activities identified above.

- Human Resources will increase by $1.55 million. GK-12 will increase by $550,000. The remainder will be used to support educational activities such as ROA, RET, and RAHSS supplements, and young investigators through CAREER awards.

EMERGING FRONTIERS $99,160,000

The FY 2007 Budget Request for the Emerging Frontiers (EF) Subactivity is $99.16 million, an increase of $18.36 million, or 22.72 percent, over the FY 2006 Current Plan of $80.80 million.

Emerging Frontiers Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Emerging Frontiers	**$73.80**	**$80.80**	**$99.16**	**$18.36**	**22.7%**
Major Components:					
Research & Education Projects	70.20	77.80	84.85	7.05	9.1%
Centers Programs					
National Evolutionary Synthesis Center	3.60	3.00	3.00	-	-
National Center for Ecological Analysis and Synthesis[1]	-	-	3.46	3.46	N/A
Center for Behavioral Neuroscience[2]	-	-	3.85	3.85	N/A
Center for Microbial Oceanography	-	-	4.00	4.00	N/A

[1] Funded in prior years in DEB.

[2] Funded in prior years in IOB.

About EF:

Emerging Frontiers supports innovative research, education, and networking activities that are built upon and integrate advances in disciplinary research. By encouraging synergy among disciplines using project, network, and centers models, Emerging Frontiers catalyzes activities at the boundaries of disciplines. EF includes BIO-initiated multidisciplinary activities, centers, and programs that contribute to Homeland Security goals, such as Microbial Genome Sequencing and Ecology of Infectious Disease. R&D for world-class research facilities, as well as the NSF priority areas (Mathematical Sciences, Human and Social Dynamics, and Biocomplexity in the Environment), is part of EF. A high EF priority is support to broaden the participation of individuals and institutions traditionally underrepresented in biological research and networking activities, thereby ensuring that these groups participate more fully in the scientific enterprise.

In general, 65 percent of the EF portfolio is available for new awards; the remaining 35 percent funds awards made in previous years.

EF priorities for FY 2007:

Frontiers in Integrative Biological Research: FIBR continues support for research on major biological questions that are addressed using the creative application of a broad range of strategies and research tools from within and outside the biological sciences. FIBR projects encompass multiple levels of organization, time and space, and a range of organisms or processes. These projects also use combined experimental and theoretical analyses, and apply interdisciplinary approaches in a single, coherent effort.

Theoretical Biology: A new research activity focused on testing and refining extant biological theory as well as developing new theory and conceptual frameworks that span biological subdisciplines and link with non-biological areas. This activity takes advantage of the information explosion in all areas of biology from genomics to ecological systems and is enabled by new analytical, modeling, simulation and cyber tools.

Biology and Society: BIO will partner with SBE to support research on the interrelationships between biological discoveries and changes in social, behavioral and economic systems.

Centers: In addition to the National Center for Synthesis in Biological Evolution previously in the EF Subactivity, three additional centers will be located in EF starting in FY 2007. The National Center for Ecological Analysis and Synthesis will be transferred from the DEB Subactivity, the STC Center for Behavioral Neuroscience will be transferred from the IOB Subactivity, and the new STC Center in Microbial Oceanography will be located in EF. Centralizing the four BIO centers in EF will promote cross-center interaction and learning while facilitating the sharing of best practices between centers and NSF center managers. As enormous amounts of genomic data, including plant biology, have flooded cyberspace, the need for additional centers for analysis and synthesis within biology, with a focus on this genomics data, will be considered within budgetary constraints.

NEON (National Ecological Observatory Network): A world-class facility for environmental research, NEON will enable ecologists for the first time to test the theory that strong and weak forces link ecological processes across the continental US, Alaska, Hawaii, and Puerto Rico. In FY 2007, funds are requested for research and development of sensor arrays that have low power requirements and will form part of NEON's completely automated biogeochemistry and biodiversity measurement systems.

Broadening Participation: BIO will broaden the participation of individuals from groups traditionally underrepresented in the biological sciences by providing planning grants for early career researchers and by funding career advancement awards to mid-career researchers to promote their professional development and retention in the biological sciences. Other BIO activities to broaden participation will also be enhanced.

Biocomplexity in the Environment (BE): In FY 2007, BIO, SBE, GEO and OPP will partner for two BE activities: Environmental Genomics (EG), including Life in the Cold and Dark, an IPY activity, and Dynamics of Coupled Natural and Human Systems (CNH). EG builds on earlier BE activities and supports research that uses genomics to understand the complex biological processes that drive environmental systems. CNH continues to fund studies to understand the dynamic interactions and interdependencies between humans and the natural environment.

Changes from FY 2006:

- Redirection of funds from other programs within EF will allow for increased support for the Frontiers in Integrative Biological Research (FIBR) program and initiation of a new program in theoretical biology. BIO will begin a collaboration with SBE on Biology and Society. Support for centers will be centralized within EF to foster collaboration and integration of research themes. (+$8.36 million)
- NEON: Support at $6.0 million for sensor array research and development.
- Broadening Participation: Support for Research Initiation Grants and Career Advancement Awards (RIG/CAA), as well as other programs focused on broadening participation, will increase by $4.0 million to a total of $8.0 million.

PLANT GENOME RESEARCH $101,220,000

The FY 2007 Budget Request for the Plant Genome Research (PGR) Subactivity is $101.22 million, an increase of $2.50 million, or 2.53 percent, over the FY 2006 Current Plan of $98.72 million.

Plant Genome Research Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Plant Genome Research	**$94.24**	**$98.72**	**$101.22**	**$2.50**	**2.5%**
Major Components:					
Research & Education Projects	94.24	98.72	101.22	2.50	2.5%

About PGR:

The Plant Genome Research (PGR) subactivity was initiated in FY 1998, building upon an existing base of genome research supported throughout BIO. PGR supports projects that make significant contributions to our understanding of plant genome structure and function. Emphasis is placed on plants of economic importance. Long-term benefits of this research include fundamental breakthroughs in our understanding of plant biology, 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 include USDA, DOE, NASA, USAID, and NIH. The NSF program follows the guidelines and objectives of the NPGI. PGR works closely with the other agencies in coordinating funding activities through the Interagency Working Group on Plant Genomes under the auspices of the National Science and Technology Council within OSTP. NSF, DOE and USDA often support joint activities, such as the Maize Genome Sequencing project and Gramene, an integrated database for cereals.

Plant biology is one of the areas for which BIO has major responsibilities, and PGR has had a major impact on plant biology research and education, thereby contributing to increased U.S. competitiveness in the development of a renewable resource-based economy of the future. Major PGR accomplishments to date include:

- Established the U.S. as the world leader in fundamental research in plant genomics;
- Transformed plant biology into a 21st century biology;
- Revitalized plant sciences at U.S. colleges and universities;
- Attracted a new generation of students to plant biology research;
- Provided an ability to address long-standing, complex questions in biology such as epigenetics, polyploidy, environmental stress tolerance, genome evolution, and cell wall synthesis; and
- Catalyzed large multinational collaborative plant genome research projects.

PGR currently supports the following specific activities:

- Development of plant genomics research resources and research tools including informatics tools
- Community databases in coordination with the USDA

- High throughput methods/techniques/technology for plant biology research
- Research translating findings from model systems to economically important plants
- Research addressing grand challenges in plant biology
- Whole genome sequencing of selected plant species
- Comparative plant genome sequencing
- Developing country collaboration in plant genomics
- Broadening participation
- Education, training, and outreach
- Participation in NSF-wide programs such as CAREER, IGERT, SGER, and support of workshops/conferences.

In general, 35 percent of the PGR portfolio is available for new awards. The remaining 65 percent will fund awards made in previous years.

PGR priorities for FY 2007:

Scientists have become increasingly able to answer long-standing major questions in plant biology because of the new tools and information resulting from PGR activities over the past 8 years. Genome-enabled plant biology research that takes full advantage of cyberinfrastructure and the latest systems biology approaches will be a high priority.

Continue Support for Maize Genome Sequencing: PGR will continue to support the interagency maize genome-sequencing project that began in FY 2005. Maize is the most economically important crop in the U.S. From a scientific standpoint, the maize genome, when completed, will become the most complex eukaryotic genome to be sequenced to date, including the human genome.
Continue Support for Comparative Plant Genome Sequencing: PGR will continue to support this new activity that began in FY 2006. The comparative plant genome sequencing program is aimed at developing sequence resources for comparative genomics studies..
Continue Support for Genome-enabled Plant Biology Research: Building on the knowledge and research resources/tools accumulated over the last eight years, scientists are poised to tackle grand challenges in plant biology.
Research Collaboration with Scientists in Developing Countries: PGR will continue to support research collaboration between U.S. scientists and scientists in developing countries with a focus on plant genomics and plant biotechnology. The activity began in FY 2004, and is coordinated with the Office of International Science and Engineering (OISE) at NSF, as well as USAID. The intent of this activity is to support collaborative research linking U.S. researchers with partners from developing countries to solve problems of mutual interest in agriculture, energy, and the environment. It will place U.S. and international researchers at the center of a global network of scientific excellence. To date, PGR has supported research collaborations with scientists from Bolivia, Brazil, India, Mexico, Nepal, Nigeria, Peru, Philippines, South Africa, and Sri Lanka.

Changes from FY 2006:

- PGR will increase by $2.50 million. The increase will be used to support the BIO-wide *Arabidopsis* 2010 Projects.
- Another competition is planned for comparative plant genome sequencing in FY 2007.

COMPUTER AND INFORMATION SCIENCE AND ENGINEERING $526,690,000

The FY 2007 Budget Request for the Computer and Information Science and Engineering (CISE) Directorate is $526.69 million, an increase of $30.28 million, or 6.1 percent, over the FY 2006 Current Plan of $496.41 million.

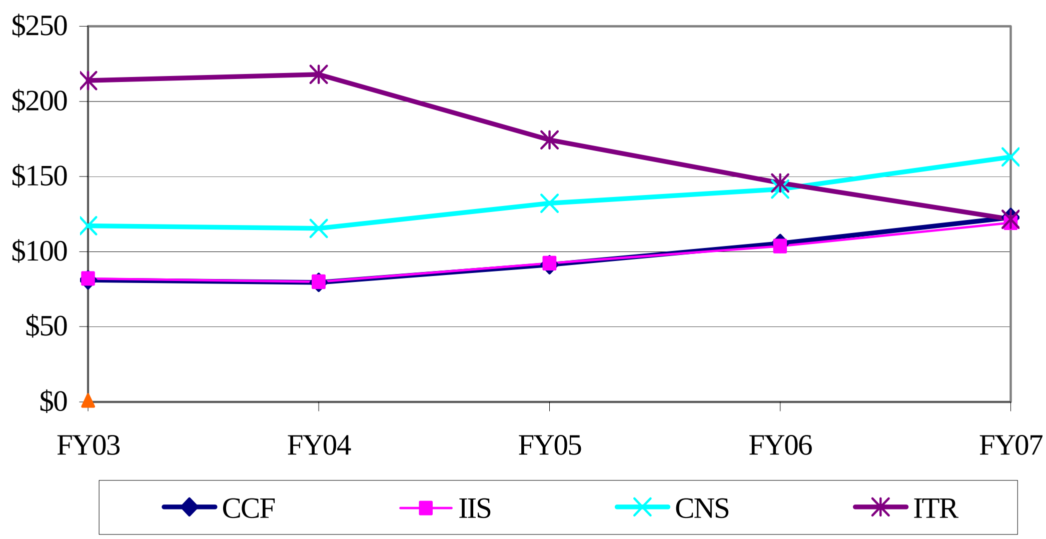
Computer and Information Science and Engineering Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Computing and Communication Foundations (CCF)	$91.29	$105.46	$122.82	$17.36	16.5%
Computer and Network Systems (CNS)	132.17	141.53	162.98	21.45	15.2%
Information and Intelligent Systems (IIS)	92.31	103.62	119.30	15.68	15.1%
Information Technology Research (ITR)	174.43	145.80	121.59	-24.21	-16.6%
Total, CISE	$490.20	$496.41	$526.69	$30.28	6.1%

Totals may not add due to rounding.

The CISE Directorate supports investigator-initiated research in all areas of computer science and engineering and related fields and contributes to the education and training of future generations of computing professionals, ensuring a supply of qualified technical personnel commensurate with national needs. CISE's Division of Shared Cyberinfrastructure was transferred to the Office of the Director in FY 2005, and renamed the Office of Cyberinfrastructure. The CISE budget has been rebased to reflect this organizational realignment. The CISE mission has been rescoped to focus on fundamental research and education in computing.

CISE Subactivity Funding
(Dollars in Millions)

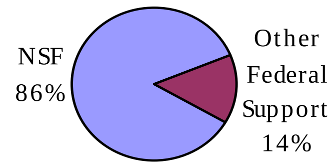


Note: The chart indicates that, with the completion of the ITR priority area, CISE ITR investments are being redirected to prominent IT research challenges and opportunities in core CISE activities in CCF, CNS and IIS.

RELEVANCE

CISE is the principal source of federal funding for university-based basic research in computer science, providing the vast majority – 86 percent – of total federal support in this area. The CISE Directorate also plays a leadership role in the multi-agency Subcommittee on Networking and Information Technology Research and Development (NITRD), co-chaired by the CISE Assistant Director. NITRD coordinating groups (CGs) that promote interagency coordination are co-chaired by CISE scientific officers.

Federal Support for Basic Research in Computer & Information Science & Engineering at Academic Institutions



Essentially, all practical applications of computing technology are ultimately based on ideas and concepts that have emerged at some point – often some years ago – from one or more basic research projects in computer science and engineering. These fundamental ideas and concepts have then enabled innovative product and application developments that now permeate essentially all areas of modern life. In turn, these practical innovations in computing-based technology not only form a sizeable portion of the economy in their own right, but are essential to innovation and effectiveness in many areas, including advanced scientific research, medical care, national and homeland defense, organizational competitiveness, and governmental efficiency.

Consistent with the Administration’s NITRD priority, in FY 2007 CISE will continue to advance the frontiers of information technology (IT) by supporting innovative research and education activities, and promoting advances in new software, hardware, systems, and algorithms. These investments include: research on new high performance computing (HPC) hardware and software architectures; homeland security areas such as cybersecurity, machine translation, artificial intelligence, computer vision, and technologies for collaboration and information retrieval; and nanotechnology via exploratory and interdisciplinary work on novel nano-based devices and architectures that promise to form the basis of future computing and communication systems.

In FY 2007, CISE will continue to capitalize on the positive outcomes of the NSF-wide Information Technology Research (ITR) priority area that ended in FY 2004. ITR, an NSF-wide priority area from FY 2000 to FY 2004, spurred innovative research, permitted work on realistic-scale problems, and built strong bridges between computing and other fields. ITR outcomes have led to the emergence of a new CISE “core”, with a greater focus on inter- and cross-disciplinary research and education activities. In FY 2007, support will continue for projects that promise to advance the computing frontier of varying size and scope, from single investigators to center-scale activities, from very basic to highly interdisciplinary, and from very local to international partnerships.

As a result of the essential and growing role of computing in society, the number of new scientific opportunities and challenges presented by the field far exceeds CISE’s ability to fund them. While CISE has always received many more quality proposals than can be funded, proposal funding rates have declined dramatically since FY 2000 as a consequence of growth in the field. CISE was able to fund 32 percent of the proposals received in FY 2000; in FY 2005, only 21 percent could be supported.

Summary of Major Changes by Division *(Dollars in Millions)*

CISE FY 2006 Current Plan……………………………………………………………………. $496.41

Computing and Communication Foundations +$17.36

Increased support will lead to the development of revolutionary software and hardware architectures that: improve the raw performance of computing systems, potentially by orders of magnitude; contribute to the improved security, reliability, and manageability of computing systems; and increase exploration of emerging computing paradigms including quantum and bio-computing. In addition, increased support will lead to new understanding of both the limits and optimal methods of computation and communication in our increasingly mobile and interconnected world.

Computer and Network Systems +$21.45

Increased funding will support projects that promote the systematic re-design of current network systems, a pressing challenge since the existing network architecture is stressed and reaching the limits of its capabilities. CNS will also support the development of sensor systems that can greatly improve our ability to predict, detect and respond to natural disasters. In addition, CNS will increase support for projects aimed at making significant breakthroughs in the design and implementation of robust and secure systems software. Improving the security of computing and communications systems is of vital national importance and is an essential component in the division's programs.

Information and Intelligent Systems +$15.68

Increased support will promote advances in Science and Engineering Informatics, informing the development of information tools and technologies that permit the effective collection, representation and analysis of very large collections of scientific data that further promotes discovery. Increased support is provided for Robust Intelligence and for Human-Centered Computing. IIS will build research capacity in areas foundational to homeland security such as machine translation, artificial intelligence, computer vision, and robotics.

Information Technology Research -$24.21

Funds are redirected to prominent IT research challenges and emerging scientific opportunities in core CISE activities in CCF, CNS, and IIS. These funds will be used to support research on Cyber Trust and to support the broader category of cybersecurity research to address threats to this critical infrastructure. ITR funds also will be used to increase core funding rates in research on high-end computing, computational science, and broadening participation in computing.

Remaining ITR funds will be used for the design and pre-construction development associated with the Global Environment for Networking Innovations (GENI) program. GENI is a facility concept currently being explored by the computing community to permit a "clean-slate" reinvention of the Internet that builds in security and robustness and that creates new applications capabilities. If not addressed successfully, limits on the current Internet will severely impede innovation, defense, and economic activity within the next ten years. GENI builds on many years of research and practical experience as well as on FY 2005 planning activities. The GENI facility will enable experimental research in computing and networked systems at scale, and will support Homeland Security activities related to Critical Infrastructure Protection.

Subtotal, Changes	+$30.28
FY 2007 Request, CISE……………………………………………………………...….	**$526.69**

Summary of Major Changes in Directorate-wide Investments *(Dollars in Millions)*

CISE FY 2006 Current Plan………………………………………………………………. **$496.41**

<u>Advancing the Frontier</u>

Fundamental Computer Science and Engineering +$14.20

Cybersecurity research and education increases by $20.0 million of which $10.0 million will increase support for the Cyber Trust program. Adjustments totaling $5.80 million will be made in core CISE programs to accommodate the full increase for cybersecurity research.

Centers Programs +$0.08

This increase restores both the Center for Embedded Networked Sensing and the Center for Ubiquitous Secure Technology to their full annual funding levels of $4.0 million.

Capability Enhancement +$0.50

Additional support of $500,000, for a total of $1.25 million, is provided for Industry/ University Cooperative Research Centers (I/UCRCs) which support industry-university partnerships, speeding the transfer of basic research outcomes into products and services.

<u>Education and Workforce Development</u>

Individuals +$2.50

CISE will provide additional support for the CAREER program to enhance opportunities for early career faculty. CISE also will provide additional support for students through the Research Experiences for Undergraduates (REU) program.

Institutions +$3.00

CISE will provide additional support for education and workforce development activities to catalyze the development of both a new integration-oriented computing curriculum and the cross-campus integration of IT education and research.

<u>Facilities and Infrastructure</u>

Infrastructure and Instrumentation +$10.00

An additional $10.0 million will support the design and pre-construction development of the Global Environment for Networking Innovations (GENI). GENI is a facility concept currently being explored by the computing community to permit a "clean-slate" reinvention of the Internet that builds in security and robustness and that creates new applications capabilities. Once completed, the GENI facility will enable experimental research in computing and networked systems at scale, and will support Homeland Security activities related to Critical Infrastructure Protection.

Subtotal, Changes	+$30.28
FY 2007 Request, CISE……………………………………………………………...….	**$526.69**

NSF-WIDE INVESTMENTS

In FY 2007, the CISE Directorate will support research and education efforts related to broad, Foundation-wide investments in a number of areas, including NSF's multidisciplinary priority areas and the Administration's interagency R&D priorities.

CISE NSF-wide Investments

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biocomplexity in the Environment	8.00	3.00	-	-3.00	-100.0%
Cyberinfrastructure	45.32	63.00	68.00	5.00	7.9%
Human and Social Dynamics	3.00	3.00	5.00	2.00	66.7%
Mathematical Sciences	2.29	2.29	1.15	-1.14	-49.8%
National Nanotechnology Initiative	7.78	12.00	12.87	0.87	7.3%
Networking and Information Technology R&D	490.20	496.41	526.69	30.28	6.1%

Biocomplexity in the Environment: In FY 2007, BE activities are transitioned into core CISE activities.

Cyberinfrastructure: A total of $68.0 million will support an increase in research on computing and communication techniques and systems that will form the cyberinfrastructure of the next decade. The challenges of scalability, security, reliability, and extensibility will be met with research and educational activities in architecture, software, networking, theory, and new underlying technologies.

Human and Social Dynamics: A total of $5.0 million will expand research in areas such as augmented cognition and the exploration of new interfaces and tools that allow people to make informed and rational decisions in spite of human limitations and biases.

Mathematical Sciences: A total of $1.15 million will emphasize interdisciplinary research and education bridging IT and mathematical disciplines, with focus on algebraic and geometric algorithms, algorithms for scalable scientific computations, and algorithms for visualization.

National Nanotechnology Initiative: A total of $12.87 million will support research in areas such as fundamental nanoscale phenomena and processes; nanoscale devices and systems; nanomanufacturing; and research facilities and instrumentation. Within CISE, these general categories encompass architecture, design, and fabrication of information systems based on nanoelectronics, representation of quantum and classical information in nanostructures, and the national infrastructure needed to support such research.

Networking and Information Technology R&D: CISE's entire request of $526.69 million is included in NITRD activities supporting fundamental research and related education in information technology and networking.

QUALITY

CISE optimizes the quality of the research 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 2005, 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 (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 December 2005, CISE convened a COV for the IIS Division. COVs also will be convened in FY 2006 for the CCF and CNS Divisions.

CISE 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; the promotion of quality graduate and undergraduate education in the computer and information science and engineering sciences; and priority investment areas in computer and information science and engineering research. The CISEAC meets twice a year with members volunteering their time to serve on subcommittees for three additional days per year. Members from both academe and industry represent a cross section of the computer and information science and engineering field, with representatives from many different sub-disciplines within the field. The CISEAC includes a balanced representation of women, underrepresented minorities, and individuals from a range of geographic regions and institutions.

PERFORMANCE

NSF's FY 2007 budget is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals and the ten investment categories highlighted in the FY 2003-2008 Strategic Plan. These categories were designed as a mechanism to better enable assessment of program performance and to facilitate budget and performance integration.

Computer and Information Science and Engineering
By Strategic Outcome Goal and Investment Category
(Dollars in Millions)

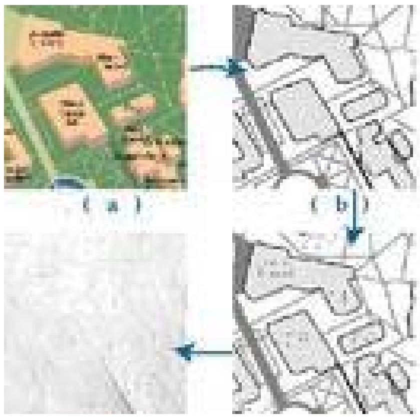
	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Ideas					
Fundamental Science and Engineering	$400.71	$389.52	$403.72	$14.20	3.6%
Centers Programs	6.03	9.92	10.00	0.08	0.8%
Capability Enhancement	0.55	0.75	1.25	0.50	66.7%
	407.29	400.19	414.97	14.78	3.7%
Tools					
Facilities	0.50	0.50	0.50	-	-
Infrastructure and Instrumentation	16.46	20.58	30.58	10.00	48.6%
Polar Tools, Facilities and Logistics	-	-	-	-	N/A
Federally-Funded R&D Centers	-	-	-	-	N/A
	16.96	21.08	31.08	10.00	47.4%
People					
Individuals	55.31	48.08	50.58	2.50	5.2%
Institutions	4.36	7.15	10.15	3.00	42.0%
Collaborations	-	14.00	14.00	-	-
	59.67	69.23	74.73	5.50	7.9%
Organizational Excellence	6.28	5.91	5.91	-	-
Total, CISE	$490.20	$496.41	$526.69	$30.28	6.1%

Totals may not add due to rounding.

CISE will continue its commitment to education, training, and increasing diversity within the computing field; the support for People reflects this commitment and represents CISE investments in the Broadening Participation in Computing (BPC) program, which encourages projects to work with local Centers of Research Excellence in Science and Technology (CREST), the Alliances for Graduate Education and Professoriate (AGEP) program, and the Louis Stokes Alliances for Minority Participation (LSAMP). Prominent IT research challenges and opportunities in the CISE Divisions of CCF, CNS and IIS are also targeted in FY 2007. At the same time, the FY 2007 request seeks to optimize funding rates and to emphasize crosscutting research and education opportunities in computing.

In FY 2007, CISE intends to launch a new education and workforce activity that will catalyze the development both of a new, integration-oriented computing curriculum and the cross-campus integration of IT education and research.

Recent Research Highlights

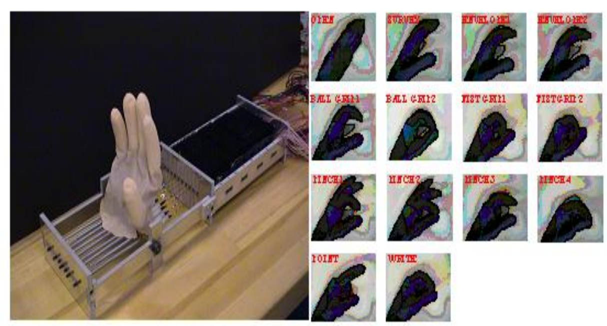


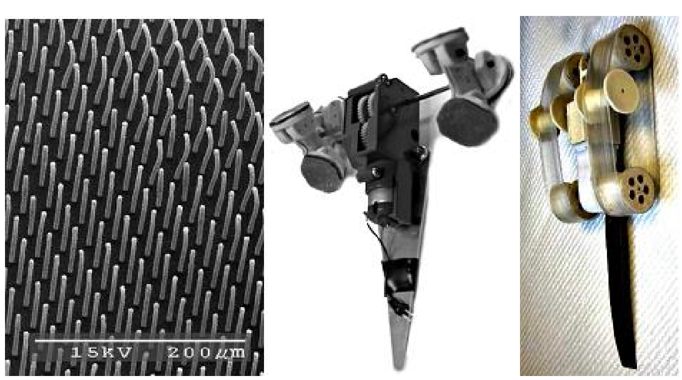
Four stages of producing a tactile image from an original image: (a) an original map, (b) a simplified map, (c) a simplified map with Braille inserted, and (d) a tactile map produced on a Tiger Embosser. Step (b) was completed automatically with our new color replacement algorithms and elementary edge detection. http://tactilegraphics.ischool.washington.edu

► **Automated Tactilization of Graphical Images: Full Access to Math, Science, and Engineering for Blind Students:** Understanding the work practices of people who create tactile graphics for the blind is crucial to developing an effective tool that will aid them in this very time- and labor-intensive work. Through a two-part study, NSF-supported researchers gained insight into how these specialists create diagrams, graphs, maps, and other tactile images for the blind in math, science, and engineering textbooks.

The research team developed image processing algorithms that automated various aspects of the image tactilization procedure, including color replacement and text identification. They then generated models to classify images by type (for example, bar charts or line graphs) so that the most appropriate image processing algorithms could be applied. The researchers will incorporate the image processing and classification algorithms into software: the Tactile Graphics Assistant. (IIS)

► **A "Natural" Robotic Hand Inspired by Biological Muscles:** An NSF-funded project is developing technology that allows a robot to have a "natural" hand with movement and features very similar to that of humans. The biologically inspired system uses multiple actuators, or devices that convert electrical control signals into physical actions, to coordinate both gross motion and fine movement with minimum architectural complexity. When applied to a five-fingered robotic hand, the novel system generated a variety of hand positions, some of which are illustrated. (IIS)



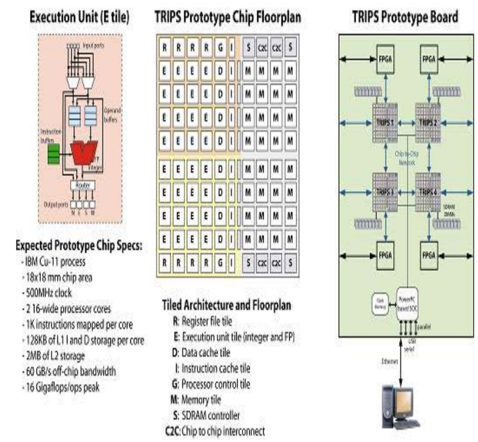


The left image shows an array of synthetic adhesive fibers 4mm in diameter that will be used to enhance the performance and robustness of climbing robots such as the ones shown in the center and right images climbing walls. *Credit: Carnegie Mellon University*

► **SGER: Biomimetic Wet Attachment Mechanism for Miniature Climbing Robots in Unstructured Environments:** A new, more efficient attachment mechanism has been developed for miniature climbing robots, enabling them to climb nearly vertical surfaces. The technology, based on methods used by beetles in nature, employs synthetics fibers to create an adhesive pad on the tread of the robot. The system generates high attachment forces with little energy input and requires only small amounts of power for detachment.

First tests demonstrated the feasibility of fabricating large areas of the synthetic fibers, and that the pads would allow a robot to climb surfaces with a 75° slope. In the near future, proposed synthetic micro/nano-structure manufacturing techniques could result in miniature climbing and walking robotic systems able to inspect bridges, buildings, nuclear facilities, and waste pipes and other hazardous or disaster-stricken areas. (IIS)

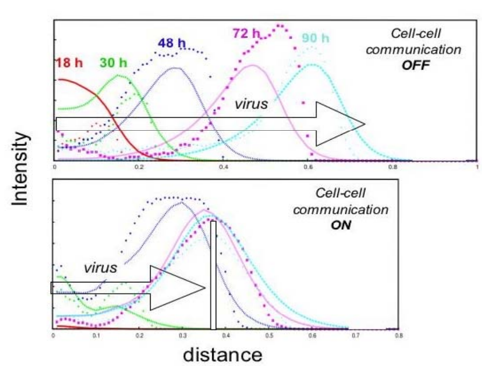
► **The Long-Term Effects of Technology on Microprocessors:** In a project co-funded by NSF and DARPA, researchers analyzed semiconductor technology trends over the next decade and designed new microprocessor architectures consistent with their findings. The team's TRIPS chip (Tera-op Reliable Intelligently-adaptive Processing System), which is now undergoing testing, is architecture that seeks to achieve significantly better performance — without the need for programmers to fine-tune the software — while using significantly less power. Two of the papers describing these ideas have received best paper awards; four others were selected for the "Top Picks in Computer Architecture" issue of *Institute of Electrical and Electronics Engineers Micro*, a journal that reaches an international audience of microcomputer and micro-processor designers, system integrators, and users. IBM Microelectronics is the fabrication partner on this project; working chips and boards are expected in early 2006. (CCF)



TRIPS Prototype Credit Doug Burger.

► **Preventing Pandemic Spread of Viruses by Cell-cell Communication:** Researchers have developed the first computational model that integrates information about virus growth and cell-cell signaling in order to understand how viral infections spread. Development of the model has been driven by a novel experimental system that enables visualization and analysis of spreading infections in a controlled laboratory setting.

Strategies to control viral diseases have focused on advancing vaccines or anti-viral drugs. Yet these approaches can fail due to the emergence of virus mutants that escape surveillance or develop drug resistance. One alternative is to utilize the innate immune response, a cellular response that up-regulates interferons (IFNs) in response to viral infections. IFNs are cell-cell signaling proteins that restrict the cellular resources needed by viruses for growth. While much is known about the molecular pathways of the IFN response, little is known about how IFN influences the dynamics of viral growth. Such advances in our quantitative understanding of innate cellular responses open opportunities for the design of new, robust anti-viral strategies. (CCF)



Other Performance Indicators

The tables below show the change in the number of people benefiting from CISE funding, and trends in the award size, duration, and number of awards.

Number of People Involved in CISE Activities

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Senior Researchers	4,825	4,825	4,975
Other Professionals	597	597	615
Postdoctorates	322	322	330
Graduate Students	4,993	4,993	5,150
Undergraduate Students	731	731	755
Total Number of People	11,468	11,468	11,825

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CISE Funding Profile

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Statistics for Competitive Awards:			
Number	1,088	1,088	1,200
Funding Rate	21%	21%	21%
Statistics for Research Grants:			
Number of Research Grants	851	851	950
Funding Rate	17%	17%	18%
Median Annualized Award Size	$112,000	$116,000	$116,000
Average Annualized Award Size	$150,000	$158,000	$158,000
Average Award Duration, in years	3.0	3.0	3.0

COMPUTING AND COMMUNICATION FOUNDATIONS $122,820,000

The FY 2007 request for the Division of Computing and Communication Foundations (CCF) is $122.82 million, an increase of $17.36 million, or 16.5 percent, over the FY 2006 Current Plan of $105.46 million.

Computing and Communication Foundations Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Computing and Communication Foundations	**$91.29**	**$105.46**	**$122.82**	**$17.36**	**16.5%**
Major Components:					
Research & Education Grants	87.29	97.54	114.82	17.28	17.7%
Science and Technology Centers					
STC for Embedded Networked Systems	4.00	3.96	4.00	0.04	1.0%
STC for Ubiquitous Secure Technology	-	3.96	4.00	0.04	1.0%

About CCF:
CCF is organized into three clusters: Theoretical Foundations, Foundations of Computing Processes and Artifacts, and Emerging Models and Technologies. Within and across these clusters, CCF supports research and education activities that explore the foundations of computing and communication devices and their usage. Research and education projects supported promote advances in computing and communication theory, algorithms for computer and computational sciences, architecture and design of computers and software, and investigations of revolutionary computing paradigms such as bio-inspired computing. CCF projects also integrate education with research to prepare future generations of computer science and engineering professionals.

In FY 2005, the CCF Division received approximately 1,300 proposals, including more high quality proposals than could be funded. The CCF funding rate was 25 percent in FY 2005. Within the FY 2006 Current Plan, approximately 35 percent of CCF funding is already committed to grants made in previous years. A portfolio that includes a “mortgage” of approximately 35 percent for ongoing grants allows CCF to maintain a funding rate of 25 percent, and ensures that a sufficient level of CCF funds are available each fiscal year for new awards. This flexibility is particularly crucial in the computing field where the pace of technological innovation is rapid.

CCF supports the Science and Technology Center for Embedded Networked Sensing (CENS) at the University of California at Los Angeles. CENS is exploring embedded networked sensing systems, large-scale, distributed systems, composed of smart sensors and actuators embedded in the physical world. These systems promise to form a critical infrastructure resource, monitoring and collecting information on such diverse subjects as plankton colonies, endangered species, soil and air contaminants, medical patients, and buildings, bridges, and other man-made structures. Across this wide range of applications, embedded networked sensing systems promise to reveal previously unobservable phenomena.

Beginning in FY 2006, CCF supports the Science and Technology Center for Ubiquitous Secure Technology at the University of California at Berkeley (TRUST). TRUST will address a parallel and accelerating trend of the past decade--the integration of secure, robust computing and communications capabilities across critical infrastructures, in areas such as telecommunications, finance, energy distribution, and transportation. The center will lead development of new technologies based on findings from studies of software and network security, trusted platforms, and applied cryptographic protocols. The center will also explore cybersecurity systems challenges through modeling and analysis, development of secure embedded systems, and integration of trusted components and secure information management software. These efforts will be merged with investigations of social science questions on economics, public policy and societal challenges, human-computer interfaces and privacy, and other issues.

CCF Priorities for FY 2007

The longer-term context of the FY 2007 request is focused on strengthening and integrating the core of computer science. All three CCF clusters, Theoretical Foundations, Foundations of Computing Processes and Artifacts, and Emerging Models and Technologies for Computation, will address the interoperability of complex systems and the need to design systems for the context in which they are used.

Strengthening the Role of Theory:

A variety of activities will be carried out that strengthen the role of theory as an incubator for new areas of computing and communications. These activities range from continued support of individual researchers through the application of theory to the foundations of connectivity and interoperability in wired and wireless networks.

Computing Processes and Artifacts:

Research will increase the robustness of hardware and software systems, supporting projects investigating architectural issues that affect performance of IT systems in real-world tasks. One such issue is interoperability: the ability of systems to share information and operate together. Other such issues are reliability, energy use, programmer productivity, and maintainability. All of these properties of hardware or software are affected by system architecture. Activities flowing from the Science of Design emphasis area will also be supported.

Emerging Models and Technologies:

Research will explore algorithms and models of computation for revolutionary technologies such as quantum information science or three-dimensional fabrication. Emphasis will continue on fabrication techniques and tools for emerging technologies. These activities will provide the basis for new computing technologies that promise computing performance improvements at the pace of Moore's Law. Moore's Law states that the number of transistors per integrated circuit will double every 18 months but this growth is expected to level off in the near future.

Cybersecurity:

Cybersecurity research will build on emphasis areas focused on software requirements for data security, new technologies for secure communication, and mathematical ways of controlling access to information.

Other Activities:

CCF will support a CISE-wide series of educational demonstration projects that will integrate IT across campuses; work on logical formalisms and algorithms for information integration; and broaden participation in computing.

Changes from FY 2006:

The FY 2007 request for CCF includes an increase of $17.36 million directed toward core research and education. Disciplinary and interdisciplinary research in the CCF core will be allocated to activities like those described above and will help maintain a proposal funding rate of 25 percent.

COMPUTER AND NETWORK SYSTEMS $162,980,000

The FY 2007 request for the Division of Computer and Network Systems (CNS) is $162.98 million, an increase of $21.45 million, or 15.2 percent, over the FY 2006 Current Plan of $141.53 million.

Computer and Network Systems Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Computer and Network Systems	**$132.17**	**$141.53**	**$162.98**	**$21.45**	**15.2%**
Major Components:					
Research & Education Grants	118.38	120.95	132.40	11.45	9.5%
Computing Research Resources	13.79	20.58	30.58	10.00	48.6%

About CNS:
The CNS Division is organized into four clusters: Computer Systems, Network Systems, Computing Research Infrastructure, and Education and Workforce. Organization into clusters minimizes stove-piping within the subdisciplines that CNS supports and allows changes in support patterns dependent on the scientific opportunities and needs of the subdisciplines represented in this division. Within and across these clusters, CNS 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 through analysis, prototyping, and experimentation, 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 to enable state-of-the-art computer science research and education, and it coordinates cross-divisional activities that foster the integration of research, education, and workforce development to develop future generations of computer science and engineering professionals.

In FY 2005, the CNS Division received over 2,100 proposals, more quality proposals than could be funded. The CNS funding rate was 20 percent in FY 2005. Within the FY 2006 Current Plan, approximately 35 percent of CNS funding is already committed towards awards made in prior years. A portfolio that includes a "mortgage" of approximately 35 percent for ongoing grants allows CNS to maintain a funding rate of 20 to 25 percent and ensures that a sufficient level of CNS funds are available each fiscal year for new awards. This flexibility is particularly crucial in the computing field where the pace of technological innovation is rapid.

CNS Priorities for FY 2007
The focus of the FY 2007 request for CNS is strengthening existing programs as well as initiating new and emerging research areas in computer and network systems, computing education, and IT workforce development.

Network Systems:
CNS supports a range of research and education activities in networking technology and systems to create next-generation networks while addressing the limitations of existing networks. The FY 2007 request

will focus on networking projects that will (1) exploit the capabilities of programmable radios to make more effective use of the frequency spectrum and to improve wireless network connectivity; (2) create architectures, tools, algorithms, and systems that make it easy to assemble and configure networks of sensor systems; and (3) expand our understanding of large, complex, heterogeneous networks, design of access and core networks based on emerging wireless and optical technologies, and continue the evolution of the Internet.

Computer Systems Research:
This cluster focuses on a variety of complex computing systems including distributed, mobile, and embedded systems, sensing and control systems, dynamically configured, multiple-component systems, and parallel systems. The FY 2007 request will continue to focus on supporting basic research in a number of important emerging areas, including high confidence system software that will control and manage computer systems so that system behavior is more predictable and analyzable, and consequently, more manageable. Another emerging area is effective system support software for large-scale, distributed dynamic applications. Effective system support will reduce the cost of system design, construction, and maintenance while increasing system performance.

Cybersecurity:
Computers reside at the heart of systems on which people rely, both in critical national infrastructures and in their homes, cars, and offices. Many of these systems are far too vulnerable to cyber attacks that can inhibit their operation, corrupt valuable data, or expose private information. Cybersecurity research will continue to address threats to this critical infrastructure. Within this effort, research in Cyber Trust supports a vision of a society in which networked computer systems are more predictable, more accountable, and less vulnerable to attack and abuse; are developed, configured, operated and evaluated by a well-trained and diverse workforce; and used by a public educated in their secure and ethical operation. In FY 2007, additional funds will be used to augment investments in the Cyber Trust program and in the broader category of cybersecurity research.

Education and Workforce Development:
In FY 2007, CISE intends to launch a new education and workforce activity that builds on a series of workshops to be held in FY 2006. These workshops bring together leading educators and researchers along with representatives from industry and professional organizations to discuss the requirements of the IT workforce of the next decade. The FY 2007 education and workforce activity will catalyze the development both of a new, integration-oriented computing curriculum and the cross-campus integration of IT education and research.

Changes from FY 2006:
The FY 2007 request for CNS includes an increase of $21.45 million that will be directed toward the following areas:

Core Research and Education: +$15.45

Disciplinary and interdisciplinary research in the CNS core will increase by $15.45 millions, including Cyber Trust. This additional support will be allocated to research priorities as described above and will help improve the funding rate in CNS.

Other Institutions Support: +$ 6.00

Funding for Other Institutions Support is increased by $6.0 million in FY 2007 for improvements in computing curriculum and integration of IT education.

INFORMATION AND INTELLIGENT SYSTEMS $119,300,000

The FY 2007 request for the Division of Information and Intelligent Systems (IIS) is $119.30 million, an increase of $15.68 million, or 15.1 percent, over the FY 2006 Current Plan of $103.62 million.

Information and Intelligent Systems Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Information and Intelligent Systems	**$92.31**	**$103.62**	**$119.30**	**$15.68**	**15.1%**
Major Component:					
Research & Education Grants	92.31	103.62	119.30	15.68	15.1%

About IIS:
The Division of Information and Intelligent Systems (IIS) supports research and education that 1) increases the capabilities of human beings and machines to create, discover and reason with knowledge; 2) advances knowledge about how computer systems perform tasks autonomously, robustly, and flexibly; 3) advances the state of the art in the application of IT to science and engineering problems; and 4) develops new knowledge about the integration of social and technical systems and capabilities. The division is organized into three clusters: Robust Intelligence, Human-Centered Computing, and Science and Engineering Information Integration Informatics. By organizing the division into clusters, stove-piping within IIS subdisciplines is minimized and flexibility in supporting emerging scientific opportunities is maximized. IIS activities also focus on the integration of research and education to prepare future generations of computer science and engineering professionals.

In FY 2005, the IIS Division received close to 1,900 proposals, including many more high quality proposals than could be funded. The overall IIS success rate was 16 percent, seven percent below the NSF average. Within the FY 2006 Current Plan, approximately 30 percent of funding is committed to continuing grant increments. Despite modest commitment to ongoing grants, IIS expects to maintain a funding rate of 16 percent across its programs.

IIS Priorities for FY 2007
The focus of the FY 2007 request for IIS is strengthening existing programs as well as initiating new and emerging research areas in information and intelligent systems. Support of research in areas such as Science of Design and Human and Social Dynamics will continue as well as participation in cybersecurity activities relating to information privacy and security.

Enabling Science and Engineering Informatics and Information Integration:
In FY 2007, IIS will support research enabling the effective management of science and engineering data that in turn leads to new discoveries in science and engineering. This topic was advocated by the National Research Council study that resulted in the book “Computing the Future” and argues that new core topics in computer science have promise for considerable impact outside of computer science. These topics include new methods of computational analysis of data such as that collected by observational sciences. IIS will also continue to focus on the challenge of providing a uniform view to a multitude of heterogeneous and independently developed data sources. This will free users from having to locate the data sources, interact with each data source in isolation, and manually combine data from multiple formats and multiple sources.

Enhancing Information Security and Privacy:
IIS participates in the Cyber Trust program. Continuing in FY 2007, IIS will support the area of Information Privacy and Security that is shared by the Robust Intelligence and Human-Centered Computing clusters. This area is exploring both technical and policy issues to insure that privacy is not compromised when data are shared and aggregated.

Promoting and Enhancing Collaboration:
In FY 2007, IIS research will focus on how collaborative research environments comprised of distributed experimental facilities and domain-specific research tools enable new scientific discoveries and education across disciplines and geography. IIS research will also continue to focus on how people, software agents, robots, and sensors contribute to collaborations that can self-organize for optimal concerted action, which is useful to society, for example, in responding to a crisis, performing surgery, or teaching children.

Technologies for Successful Aging:
In FY 2007, a focus will be on research that enables adults to remain involved and capable of living a longer independent life through the development of technologies and environments that automatically adapt to competencies and skills of the user.

Changes from FY 2006:

The FY 2007 request for IIS includes an increase of $15.68 million directed toward core research and education in areas such as those highlighted previously. This funding increase will also help, at a minimum, to maintain the current funding rate.

INFORMATION TECHNOLOGY RESEARCH $121,590,000

The FY 2007 request for the Information Technology Research (ITR) Subactivity is $121.59 million, a decrease of $24.21 million, or 16.6 percent, below the FY 2006 Current Plan of $145.80 million.

Information Technology Research Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Information Technology Research	**$174.43**	**$145.80**	**$121.59**	**-$24.21**	**-16.6%**
Major Component:					
Research & Education Grants	174.43	145.80	121.59	-24.21	-16.6%

About ITR:
During FY 2000 - FY 2004, the ITR Subactivity provided for CISE investments in the agency-wide ITR priority area. It provided support for state-of-the-art IT research and related education activities; enhanced support for more focused research in areas of national importance such as cyber security, homeland security, and cyberinfrastructure; and permitted the funding of a larger number of complex, often interdisciplinary, projects.

In FY 2006, approximately 65 percent of ITR funds are committed to projects established in prior fiscal years. The remaining 35 percent of funds are available to make new awards in crosscutting areas in computing.

ITR Priorities for FY 2007
Funds available in the ITR Subactivity will be used to target IT priorities in the core CISE Subactivities of CCF, CNS, and IIS as well as prominent CISE-wide IT research and education priorities as described below.

Global Environment for Networking Innovations (GENI):
In FY 2007, ITR will support the design and pre-construction development associated with the Global Environment for Networking Innovations (GENI) program. GENI is a facility concept currently being explored by the computing community to permit a “clean-slate” reinvention of the Internet that builds in security and robustness and that creates new applications capabilities. If not addressed successfully, limits on the current Internet will severely impede innovation, defense, and economic activity within the next ten years. GENI builds on many years of research and practical experience as well as FY 2005 planning activities. The GENI facility will enable experimental research in computing and networked systems at scale, and will support Homeland Security activities related to Critical Infrastructure Protection.

Cybersecurity:
In FY 2007, ITR funds will be used to support cybersecurity research to address current and known threats to this critical infrastructure. Within this effort, research in Cyber Trust supports a vision of a society in which networked computer 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. In FY 2007, ITR funds will be used to support the Cyber Trust program and the broader category of cybersecurity research.

High-End Computing and Computational Science:
In FY 2007, ITR will continue to emphasize fundamental research on high-end software and hardware systems that are designed specifically to address important computation- and data-intensive science and engineering opportunities and challenges. Research activities will focus on building complex software and tools for high-end computing architectures; developing multi-scale analysis methods in computational science; and developing more sophisticated information management and data analysis tools and technologies to support the analysis of scientific data and information.

Broadening Participation in Computing:
The Broadening Participation in Computing (BPC) emphasis area aims to significantly increase the number of domestic students receiving postsecondary degrees in the computing disciplines. CISE will continue to support BPC projects in FY 2007 with ITR funds.

Changes from FY 2006:
In FY 2007, CISE will redirect $24.21 million from the broad category of IT Research to IT priorities in the core CISE Subactivities of CCF, CNS, and IIS. With funds available in the ITR Subactivity, CISE will fund the research, education, and workforce preparation priorities described above.

ENGINEERING $628,550,000

The FY 2007 Budget Request for the Directorate for Engineering (ENG) is $628.55 million, an increase of $47.63 million, or 8.2 percent, over the FY 2006 Current Plan of $580.92 million.

Engineering Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Chemical, Bioengineering, Environmental and Transport Systems (CBET)	$112.06	$122.87	$124.44	$1.57	1.3%
Civil, Mechanical and Manufacturing Innovation (CMMI)	141.13	146.79	152.16	5.37	3.7%
Electrical, Communications and Cyber Systems (ECCS)	70.79	77.27	80.90	3.63	4.7%
Industrial Innovation and Partnerships (IIP)	113.10	110.56	120.08	9.52	8.6%
Small Business Innovation Research (SBIR/STTR)	[102.75]	[100.36]	[108.88]	[8.52]	[8.50%]
Engineering Education and Centers (EEC)	120.01	123.43	125.97	2.54	2.1%
Emerging Frontiers in Research and Innovation (EFRI)	-	-	25.00	25.00	N/A
Total, ENG	$557.09	$580.92	$628.55	$47.63	8.2%

Totals may not add due to rounding.

Engineering is the foundation of our Nation's global leadership in technology and innovation. This leadership is the key to our continued economic growth and national security. Engineering also serves as the bridge between science and society, where the fruits of basic research and education are transformed into new technologies and robust systems that make our lives better, safer, and more productive.

The U.S. engineering community continually applies its ingenuity and technical expertise to ensure our Nation is able to rise above today's pressing demands, even as we prepare to meet tomorrow's emerging grand challenges. Many of these frontier challenges are already in the national spotlight, as recent news reports communicate the urgent need for engineering solutions. Protecting our coastlines from potential tsunami and hurricane damage, making meaningful strides toward energy independence, and educating a future workforce that can not only compete, but excel in an era of global competitiveness are just some of the areas where engineers are working toward solutions.

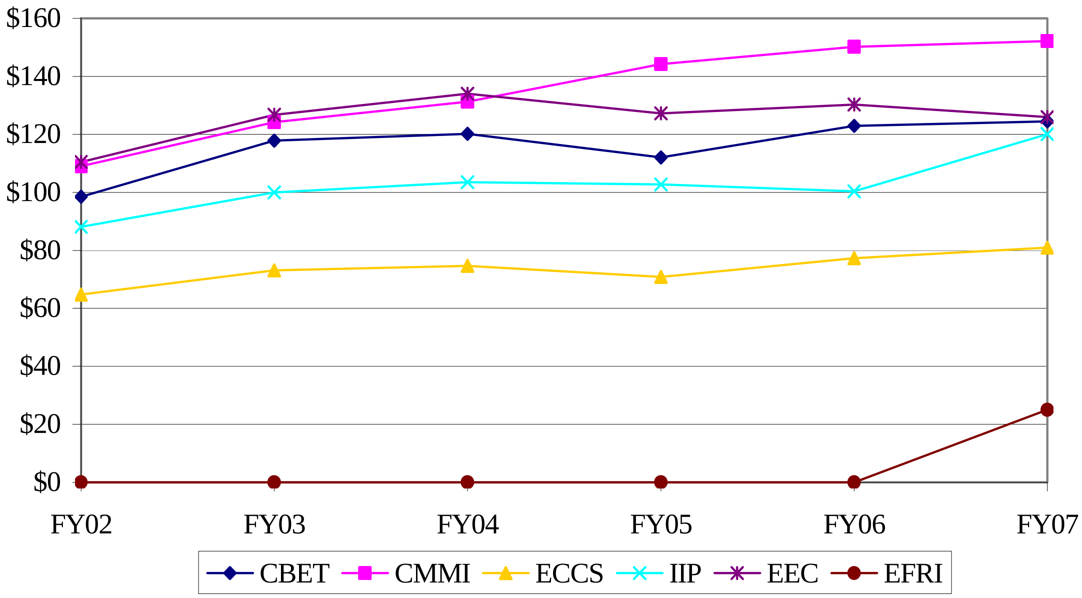
Engineering, therefore, is the catalyst that brings about improvements in personal lives and critical advances in our Nation's strategic interests. It is through investments in fundamental and frontier engineering research that we are able to bring about profound and positive impacts on areas such as environmental protection, improving human health, enabling science to better understand the natural world, and growing our standard of living.

Engineering spans the frontiers from nanotechnology and high-end computing to homeland security and understanding complex engineered and natural systems. Throughout traditional and emerging disciplines, engineering applies fundamental research to service in society.

To ensure that NSF will continue to provide national leadership in engineering research and education, ENG must continually assess its resource allocation and organizational effectiveness. This process, by evaluating the impact of national needs and international competitiveness, led to the decision to restructure the Engineering Directorate in FY 2007. This restructuring will strategically position ENG's investments to help secure the Nation's leadership in innovation, particularly in an increasingly competitive global marketplace for goods and ideas.

A crosswalk to ENG's new framework of the FY 2006 Current Plan is provided at the end of this document.

ENG Subactivity Funding
(Dollars in Millions)

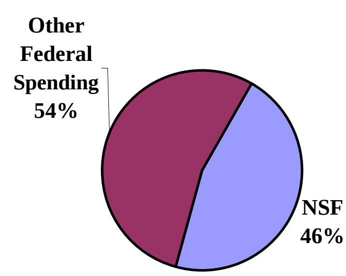


RELEVANCE

The Engineering Directorate is a major source of federal funding for university-based, fundamental engineering research – providing 46 percent of the total federal support in this area.

ENG investments in engineering research and education build and strengthen our Nation's capacity to lead the world in innovation. These investments include such emerging technologies as sensors and sensor systems, molecular electronics, photonics, cyberinfrastructure, metabolic engineering, bioengineering, manufacturing innovation, and nanotechnology.

Federal Support of Basic Research in Engineering at Academic Institutions



ENG also receives feedback and input from the Engineering Advisory Committee and the engineering community to advance the frontiers of discovery, enable technological innovation, and transform education to serve the current and future demands of society. From new fields like nanotechnology to the core disciplines of civil, chemical, electrical, and mechanical engineering – the NSF Engineering Directorate supports the most creative ideas with a proven system of merit review.

Summary of Major Changes by Directorate-wide Investments *(Dollars in Millions)*

ENG FY 2006 Current Plan…………………………………………………………………….. $580.92

<u>Advancing the Frontier</u>

Disciplinary and Interdisciplinary Research +$45.73

Support for core research projects will be increased significantly. ENG will allocate $25.0 million to support research aimed at advancing the frontiers of knowledge and innovation by working across traditional disciplinary boundaries in the ENG priority research areas of Biology in Engineering, New Frontiers in Nanotechnology, Critical Infrastructure Systems, Complexity in Engineered and Natural Systems, and Manufacturing Frontiers. These frontier research areas will guide the decision making process throughout ENG, but specifically within the Office of Emerging Frontiers in Research and Innovation (EFRI). The EFRI Office will reside within the Office of the Assistant Director for Engineering, and will consider areas of emerging frontiers of engineering research, innovation, and education. The Office of Emerging Frontiers in Research and Innovation will serve a critical role in helping the Directorate for Engineering focus on important new areas. Funding for other core research increases slightly to enable funding of higher priority emerging frontier research and innovation.

Sensors and Related Research - In FY 2007, $20.0 million is requested to support leading edge, frontier research across NSF on sensors and other research that is potentially relevant to the prediction and detection of explosives and related threats. ENG will lead this new NSF-wide effort, in collaboration with other agency efforts, which seeks to advance fundamental knowledge in new technologies for sensors and sensor networks, and in the use of sensor data in control and decision-making across a broad range of applications, particularly those that bear on the prediction and detection of explosive materials and related threats. Additional information is provided in the chapter on NSF-wide Investments.

Priority Areas - Biocomplexity in the Environment (BE) and Mathematical Sciences (MSE) priority areas will continue their phase-downs, transferring into core programs where these emphases will continue within ongoing projects. Human and Social Dynamics (HSD) is sustained at the FY 2006 Current Plan level in FY 2007.

Earthquake Engineering Centers -$6.00

Funding for three earthquake engineering centers will end in FY 2006. These centers, awarded in FY 1997, were a part of the National Earthquake Hazards Reduction Program (NEHRP), and helped to highlight the Nation's need for the Network for Earthquake Engineering Simulation (NEES).

Engineering Research Centers Funding decreases by $630,000, to a total of $62.79 million resulting in a slight decrease of support for outreach supplements.	-$0.63
Small Business Innovation Research Funding increases by $7.63 million, to a total of $97.47 million to meet the mandated agency spending target of 2.5 percent of the agency's extramural research budget.	+$7.63
Small Business Technology Transfer Funding increases by $890,000, to a total of $11.41 million to meet the mandated agency spending target of 0.30 percent of the agency's extramural research budget.	+$0.89
<u>Broadening Participation in the S&E Enterprise</u>	
Research Experience for Undergraduates (REU) Sites Support for the REU Sites program increases by $100,000, to a total of $8.60 million.	+$0.10
Engineering Education Support for unsolicited engineering education projects in core programs decreases. In conjunction with the EHR Directorate, ENG will (1) reallocate existing collaborations funding to provide initial support for the development of minority faculty networks, drawing upon highly successful ENG minority workshops, and (2) undertake a collaborative planning process with tribally-controlled colleges and universities to foster the development of pathways for American Indian students to become engineers.	-$1.93
<u>Bolstering NSF's K-12 Education Portfolio</u>	
Research Experiences for Teachers (RET) Support for the RET Sites program increases by $100,000, to a total of $4.10 million.	+$0.10
GK-12 Support for the GK-12 program increases by $180,000, to a total of $3.37 million.	+$0.18
<u>Facilities and Infrastructure</u>	
Network for Earthquake Engineering Simulation (NEES) Funding for operations and maintenance costs increase $960,000, to a total of $21.27 million.	+$0.96
<u>Organizational Excellence</u> 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.	+$0.25
Net, all other program changes	+<u>$0.35</u>
Subtotal, Changes	+$47.63
FY 2007 Request, ENG…………………………………………………………………	**$628.55**

NSF-wide Investments

In FY 2007, the Engineering Directorate will support research and education efforts related to broad, Foundation-wide investments in a number of areas, including NSF's multidisciplinary priority areas and the Administration's interagency R&D priorities.

Engineering NSF-wide Investments

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biocomplexity in the Environment	$6.00	$5.94	$4.00	-$1.94	-32.7%
Climate Change Science Program	1.00	1.00	1.00	-	-
Cyberinfrastructure	52.00	52.00	54.00	2.00	3.8%
Human and Social Dynamics	2.00	2.00	2.00	-	-
Mathematical Sciences	2.91	2.88	1.46	-1.42	-49.3%
National Nanotechnology Initiative	123.77	127.77	137.02	9.25	7.2%
Networking and Information Technology R&D	11.20	11.20	11.20	-	-
Sensors/IED Research	-	-	20.00	20.00	-

Biocomplexity in the Environment: A total of $4.0 million will support activities in the Materials Use: Science, Engineering, and Society (MUSES) program.

Climate Change Science Program: A total of $1.0 million to support basic research in the areas of carbon dioxide capture and the reduction of other greenhouse gases.

Cyberinfrastructure (CI): ENG currently funds projects such as NEES – the George E. Brown Jr. Network for Earthquake Engineering Simulation – NSF's first distributed-network cyberinfrastructure research facility, the National Nanotechnology Infrastructure Network (NNIN), and the Nanoscale Computational Network (NCN). In FY 2007, support increases by $2.0 million to a total of $54.0 million and will be used to fund ENG projects at the device, node, network, and system levels that will enable enhanced capabilities for the next generation cyberinfrastructure. Funding will also be used to support projects that use CI to enable frontier research in ENG domain areas.

Human and Social Dynamics: A total of $2.0 million will be invested in Decision Making and Risk and Dynamics of Human Behavior components of this priority area.

Mathematical Sciences: A total of $1.46 million will continue to support synergistic collaborations between mathematicians and engineers to strengthen engineering modeling and experimental work, and enhance undergraduate and graduate engineering education.

National Nanotechnology Initiative: NSF leads the U.S. nanotechnology research effort, and ENG is the focal point within NSF for this critical national research endeavor. The goal is to support fundamental research and catalyze synergistic science and engineering research and education in emerging areas of nanoscale science and technology. This research includes biosystems at the nanoscale; nanoscale structures, novel phenomena, and quantum control; nanoscale devices and system architecture; nanoscale processes in the environment; multi-scale, multi-phenomena theory, modeling and simulation at the nanoscale; manufacturing processes at the nanoscale; and studies on the societal and educational implications of scientific and technological advances on the nanoscale. Within the total investment for NNI, ENG will fund approximately 30 new awards on Nanoscale Interdisciplinary Research Teams (NIRT) or NIRT-like projects ($65.0 million across NSF). FY 2007 ENG support for NNI increases by $9.25 million to a total of $137.02 million.

Networking and Information Technology R&D: ENG supports a broad array of fundamental computer and network research, including the Control, Networks and Computational Intelligence (CNCI) program, which covers creative research and education underlying the analysis and design of intelligent engineering networks for control, communications, computation and energy. Additionally, FY 2007 support remains constant at $11.20 million.

Sensors/IED Research: NSF is requesting $20.0 million to support leading edge, frontier research across NSF on sensors and other research that is potentially relevant to the prediction and detection of explosives and related threats. ENG will lead this new NSF-wide effort, in collaboration with other agency efforts, which seeks to advance fundamental knowledge in new technologies for sensors and sensor networks, and in the use of sensor data in control and decision-making across a broad range of applications, particularly those that bear on the prediction and detection of explosive materials and related threats. Additional information is provided in the chapter on NSF-wide Investments.

QUALITY

ENG maximizes the quality of the R&D it supports through the use of a competitive, merit-based review process. In FY 2005, 97 percent of research funds were allocated to projects that underwent external merit review.

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.

ENG 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 engineering 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. Its members represent a cross section of engineering, with representatives from many different sub-disciplines within the field. Members also come from a variety of institutions, have broad geographic representation, and represent a balance of underrepresented groups.

PERFORMANCE

NSF's FY 2007 budget is also aligned to reflect funding levels associated with the Foundation's four strategic outcome goals and the ten investment categories highlighted in the FY 2003-2008 Strategic Plan. These categories were designed as a mechanism to better enable assessment of program performance and to facilitate budget and performance integration.

Engineering
By Strategic Outcome Goal and Investment Category
(Dollars in Millions)

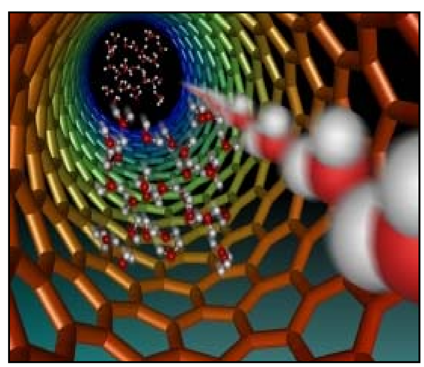
	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Ideas					
Fundamental Science and Engineering	$229.25	$245.64	$291.37	$45.73	18.6%
Centers Programs	97.53	99.13	92.58	-6.55	-6.6%
Capability Enhancement	109.18	107.16	115.68	8.52	8.0%
	435.96	451.93	499.63	47.70	10.6%
Tools					
Facilities	27.34	29.61	30.67	1.06	3.6%
Infrastructure and Instrumentation	-	-	-	-	N/A
Polar Tools, Facilities and Logistics	-	-	-	-	N/A
Federally Funded R&D Centers	-	-	-	-	N/A
	27.34	29.61	30.67	1.06	3.6%
People					
Individuals	70.05	71.45	71.97	0.52	0.7%
Institutions	15.48	18.18	16.28	-1.90	-10.5%
Collaborations	1.00	2.00	2.00	-	-
	86.53	91.63	90.25	-1.38	-1.5%
Organizational Excellence	7.26	7.75	8.00	0.25	3.2%
Total, ENG	$557.09	$580.92	$628.55	$47.63	8.2%

Totals may not add due to rounding.

ENG will continue its commitment to education, training, and increasing diversity within all of its Divisions. The FY 2007 budget will maintain award size and continue to focus on multidisciplinary research activities, interagency partnerships, and international activities with special attention given to broadening participation at all levels.

Recent Research Highlights

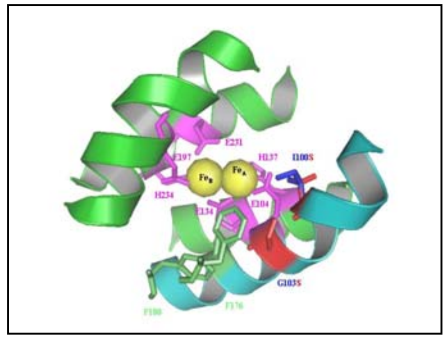
► **Novel Membranes for Manufacturing and Drug Delivery:** Researchers at the University of Kentucky have created membranes made from billions of aligned carbon nanotubes, and verified that some fluids will stream through the almost friction-free nanotube interiors at nearly 100,000 times the rates predicted by standard fluid-flow theory. Although other researchers have speculated that carbon nanotubes would have little friction, the University of Kentucky team, led by an NSF-funded CAREER awardee, was the first to document the high-speed flow.



Water moving through carbon nanotubes.
Credit: M.Denomme, University of Kentucky.

Highly efficient nanotube-based filters may one day contribute to the purification of products ranging from industrial chemicals and pharmaceuticals to dairy production. (CBET)

► **A Better Approach to Producing Drugs for Parkinson's Disease:** Researchers at the University of Connecticut and the University of Maryland have used protein engineering to construct enzymes that are useful in the pharmaceutical industry. These enzymes were used to develop a new class of compounds that show promise for the treatment of Parkinson's disease and other nervous system disorders. These compounds, known as 4-nitrocatechols, could not be produced in the past without also producing substantial impurities that could pose a health risk. By using an engineered enzyme, however, the researchers have now discovered a new biosynthetic pathway to produce the compounds with fewer impurities.



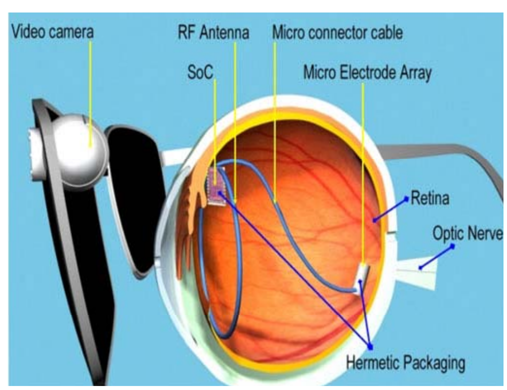
Active site of the Monooxygenase enzyme, which gives better control in the development of drugs for Parkinson's disease. *Credit:: T. Wood, University of Connecticut Bioremediation and Applied Biotechnology Laboratory.*

Enzymes play a key role in the development of many pharmaceuticals by catalyzing the reactions needed to produce drugs. However, it is difficult to obtain the enzymes that are required to form specific drugs. The researchers used directed evolution of enzyme-producing bacteria to rapidly develop the enzymes that they needed. This enzyme gave them better control of drug development, and produced a purer form of 4-nitrocatechol for the treatment of Parkinson's disease. (CBET)

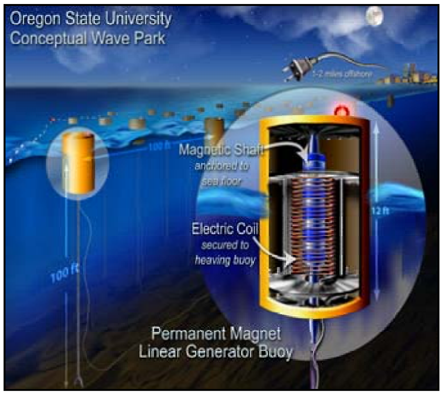
Penelope prepares for her surgical debut. *Credit: Courtesy of New York-Presbyterian Hospital.*

► **Robots in the Operating Room:** A team of engineers and surgeons at Robotic Surgical Tech Inc. have developed a robotic surgical assistant known as "Penelope." Through the use of a robotic arm, voice-recognition technology, and artificial intelligence techniques, Penelope can respond to a surgeon's request for an instrument – often by anticipating the surgeon's needs and having the instruments ready in advance. It can also keep track of what's been used so far, helping to ensure that nothing is accidentally left inside the patient. Penelope made its clinical debut in June 2005 at New York-Presbyterian/The Allen Pavilion, where it participated in a simple excision of a small, benign cyst. (IIP)

► **Retinal Implant Restores Light to the Blind**: Millions of people who have lost their sight due to degenerative eye diseases such as Macular Degeneration may one day see again, thanks to recent progress toward engineering an artificial retina. A research group from the NSF Engineering Research Center for Biomimetic Microelectronic Systems at the University of Southern California has developed a device that enables previously blind individuals to perceive light and patterns. The researchers discovered that, in many cases, the neural pathways of blind people that carry information to the brain were still healthy, even though other parts of the eye were not. The retinal implant takes advantage of this healthy neural tissue by using an external camera and image-processing unit to send signals through the optic nerve to the brain. It is hoped that a clinically approved version will be available for widespread use within five years. (EEC, CBET)



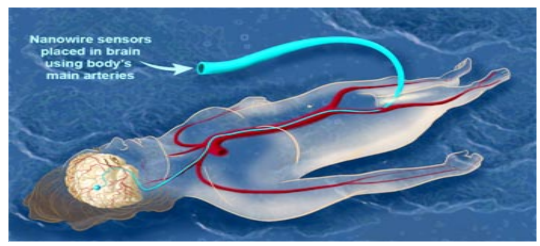
Drawing of an implanted artificial retina. *Credit: University of Southern California Biomimetric MicroElectronic Systems Research.*



Ocean buoy generators promise to convert the movement of waves into energy. *Credit: Nicole Fuller, National Science Foundation.*

► **Power from the Ocean**: Engineers at Oregon State University have developed buoys that can harness the motion of the ocean to produce electricity. The power-generating buoys use the fundamental relationship between electricity and kinetic energy to convert waves in the water into energy we can use. Inside each buoy, a series of electric coils surround a magnetic shaft that is anchored to the seafloor. When waves cause the coil inside the buoy to move up-and-down relative to the fixed magnetic shaft, electricity is generated. Each buoy could potentially produce 250 kilowatts of power, and the technology can be scaled up or down to suit a variety of energy needs. A fleet of about 200 such buoys could power the business district of downtown Portland. (ECCS)

► **Nanowire Probes in the Brain:** Working with platinum nanowires 100 times thinner than a human hair, a team from New York University School of Medicine and Japanese researchers has demonstrated a technique that may one day allow doctors to monitor individual brain cells and perhaps provide new treatments for neurological diseases such as Parkinson's. The researchers explain it is becoming feasible to create nanowires far thinner than even the tiniest capillary vessels. That means nanowires could, in principle, be threaded through the circulatory system to any point in the body without blocking the normal flow of blood or interfering with the exchange of gasses and nutrients through the blood-vessel walls. (CMMI)



Nanowires connected to a catheter tube could be guided hrough the circulatory system to the brain. Each nanowire would record the electrical activity of a single nerve cells, or small groups of nerve cells. *Credit: Zina Deretsky, National Science Foundation.*

Image of the Like90 unmanned helicopter. *Credit: Like90, University of South Florida's Safety Security Rescue Research Center.*

► **Small Unmanned Aircraft Save Lives:** Two small, unmanned aircraft played a key role in saving lives after Hurricane Katrina. NSF-supported researchers brought the vehicles to storm-damaged communities in Mississippi to help responders focus their efforts and avoid hazards. In Pearlington, Mississippi, researchers launched the aircraft from an open patch of road, which was surrounded by downed trees and power lines.

One vehicle, a four-foot long, fixed-wing plane carrying video and thermal cameras, gave a broad view of the disaster area. The other, a miniature helicopter able to operate up to 300 feet in the air, allowed researchers to hover near particular buildings and roofs, assess the damage, and locate survivors who were trapped. (EEC)

Other Performance Indicators

The tables below show the change in the number of people benefiting from ENG funding, and trends in the award size, duration, number of awards, and funding rates.

Number of People Involved in ENG Activities

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Senior Researchers	4,700	4,888	5,181
Other Professionals	1,219	1,268	1,344
Postdoctorates	387	402	426
Graduate Students	4,402	4,578	4,853
Undergraduate Students	2,202	2,290	2,427
Total Number of People	12,910	13,426	14,231

ENG Funding Profile

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Statistics for Competitive Awards:			
Number	1,493	1,553	1,677
Funding Rate	17%	18%	20%
Statistics for Research Grants:			
Number of Research Grants	840	874	1,020
Funding Rate	13%	14%	15%
Median Annualized Award Size	$97,431	$97,500	$98,000
Average Annualized Award Size	$117,675	$118,000	$119,200
Average Award Duration, in years	2.9	2.9	2.9

New Structure
Engineering Directorate

In FY 2007, the Engineering Directorate will be restructured. This is to ensure that ENG can continue to address the needs of the Nation, while responding to ongoing changes in engineering research and education. As such, ENG has prepared a framework for reorganizing the Activity. A crosswalk of the FY 2006 Current Plan is shown below.

Current Structure	New Structure						Total Current Structure
	CBET	CMMI	ECCS	IIP	EEC	EFRI	
Bioengineering and Environmental Systems (BES)	52.00						$52.00
Chemical and Transport Systems (CTS)	70.87						$70.87
Civil and Mechanical Systems (CMS)		85.35					$85.35
Design and Manufacturing Innovation (DMI)		61.44		3.40			$64.84
Electrical and Communications Systems (ECS)			77.27				$77.27
Engineering Education and Centers (EEC)				6.80	123.43		$130.23
Office of Industrial Innovation (OII)				100.36			$100.36
Total, New Structure	$122.87	$146.79	$77.27	$110.56	$123.43	$0.00	$580.92

The Engineering Directorate is constantly seeking ways to better fulfill its mission of advancing engineering discovery, innovation, and education. For the past 15 years, ENG has been able to fulfill this mission using effectively the same organizational structure.

During that time, however, new research areas have emerged and advanced (e.g., nanotechnology, bioengineering). National priorities have changed (e.g., homeland security and energy independence). And global competition in innovation has increased.

With these changing conditions, and new and emerging demands on the engineering enterprise, ENG must reposition itself to remain at the frontier of discovery, innovation, and education.

To respond proactively to these changes, ENG has unveiled a framework for reorganizing the Activity. This framework will continue to enable ENG to do the following:

- Position ENG at the frontiers of engineering discovery, innovation and education;
- Enhance interdisciplinary research;
- Provide opportunities for exploring new areas not yet recognized in their full potential;
- Enhance flexibility for evolutionary change by combining some units;
- Better integrate across priority areas;
- Enhance the integration of research and education; and,
- Support the continuum from discovery through early engineering innovation.

The new structure reflects a series of overarching goals for the ENG Directorate, and better aligns with national priorities. One of the overarching goals – ***frontier research*** – recommended frontier research areas for FY 2007 emphasis. They are:

- Biology in Engineering
- Complexity in Engineered and Natural Systems
- Critical Infrastructure Systems
- Manufacturing Frontiers
- New Frontiers in Nanotechnology

These frontier research areas will guide the decision-making process throughout ENG, but specifically within the Emerging Frontiers in Research and Innovation (EFRI) budget line. The EFRI Office will reside within the Office of the Assistant Director for Engineering and will consider areas of emerging frontiers of engineering research, innovation, and education. The EFRI Office will identify and prioritize emerging frontier areas of research and education, and provide resources for pursing these priorities. EFRI will serve a critical role in helping the Directorate for Engineering focus on important new areas.

Also, as part of the reorganization, the Industry/University Cooperative Research Centers (I/UCRCs) program will be moved from the Engineering Education and Centers Division to the Industrial Innovation and Partnerships (IIP) Division. The program develops long-term partnerships among industry, academe, and government. The centers are catalyzed by a small investment from the NSF, and are primarily supported by industry center members, with NSF taking a supporting role in their development and evolution. Each center is established to conduct research that is of interest to both the industry and the center. An I/UCRC contributes to the Nation's research infrastructure base and enhances the intellectual capacity of the engineering and science workforce through the integration of research and education.

Finally, the Grant Opportunities for Academic Liaison with Industry (GOALI) program moves from the Civil, Mechanical and Manufacturing Innovation Division to the IIP Division. The program enables partnerships between industry and academe where there is a common intellectual and educational agenda. The program supports (a) faculty, postdoctoral fellows, and students to conduct research and gain experience in an industrial setting; (b) industry scientists and engineers to bring industrial perspective and integrative skills to academe; and (c) interdisciplinary university/industry teams to conduct long-term projects. The program targets high-risk and high-gain research, with focus on fundamental topics that would not otherwise have been undertaken by industry; the development of innovative, collaborative university/industry educational programs; and the direct exchange of new knowledge between academe and industry.

CHEMICAL, BIOENGINEERING, ENVIRONMENTAL AND TRANSPORT SYSTEMS $124,440,000

The FY 2007 Budget Request for the Chemical, Bioengineering, Environmental and Transport Systems Division (CBET) is $124.44 million, an increase of $1.57 million, or 1.3 percent, above the FY 2006 Current Plan of $122.87 million.

Chemical, Bioengineering, Environmental and Transport Systems Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Chemical, Bioengineering, Environmental, and Transport Systems	**$112.06**	**$122.87**	**$124.44**	**$1.57**	**1.3%**
Major Components:					
Research and Education Grants	100.81	110.45	111.95	1.50	1.4%
Science and Technology Center (STC)	4.00	3.96	4.00	0.04	1.0%
National Nanoscale Infrastructure Network (NNIN)	3.20	3.17	3.20	0.03	0.9%
Nanoscale Science and Engineering Centers (NSEC)	4.05	5.29	5.29	-	-

About CBET:

The Division of Chemical, Bioengineering, Environmental and Transport Systems (CBET) Division supports fundamental research and education in the rapidly evolving, and increasingly interconnected fields of bioengineering, chemical and environmental engineering, and transport systems. This research will have profound effect on the U.S. economy; the health of our land, air, and water environments; our understanding of natural and living systems; and our ability to provide outstanding healthcare. CBET will advance these fields by developing fundamental engineering principles, mathematical models and experimental techniques, and new devices and systems.

In general, 67 percent of the CBET portfolio is available for new awards. The remaining 33 percent funds awards made in previous years.

CBET Priorities for FY 2007:
The division will continue to support existing areas of frontier research within the Engineering Directorate. This includes fundamental studies of catalysis and biocatalysis, bioengineering, chemical and biochemical process design, environmental engineering, advanced materials, fuel cells, combustion, heat transfer, and particle processes. It also will support new areas of research at the nexus of bioengineering, chemical engineering, and environmental transport phenomena. By integrating research from these diverse disciplines, CBET will be able foster new discoveries and new innovations in the areas that most directly affect our quality of life. Within the U.S. and international research communities, CBET support will play a key role in catalyzing and developing highly promising, cutting-edge research fields, such as: tissue engineering, energy, the environment, information technologies, health-related products, and other areas that impact our daily lives.

CBET achieves these objectives across its four program clusters:

- Chemical, Biochemical, and Biotechnology Systems
- Transport and Thermal Fluids Phenomena

- Biomedical and Healthcare Engineering
- Environmental Systems

While sustaining the vitality of these core research areas, CBET actively supports the following key areas:

Energy, Environment, and Sustainability: CBET will continue to support research on environmentally benign processes. Energy conversion areas include cleaner combustion processes, the fabrication of new materials for solar cells, novel electrode materials for fuel cells, microbial fuel cells, liquid biofuels, and biohydrogen. The management of greenhouse gases with their links to climate change will be supported. CBET leads the WATERS Network project, which has as its objective the transformation water resource engineering research at a national scale.

Nanoscale Science and Engineering: CBET will continue its leadership role in designing, synthesizing, and analyzing nanoscale systems. Current emphasis is on active nanoscale systems leading to improved devices and manufacturing techniques. CBET also plays a key role in funding exploratory research on biosystems at the nanoscale. For example, chips and sensors, combined with microfluidics, are integrated intimately with nanobiotechnology. Many of these systems are for medical, environmental, and other sensing applications.

Cyberinfrastructure (CI): Cyberinfrastructure efforts are pervasive throughout the division's programs. Projects involving computational fluid dynamics are funded throughout CBET, and draw increasingly on high-performance computing (HPC) capabilities that are being enhanced by NSF-level CI initiatives. Further, as part of the WATERS network effort, a Project Office has been established and will focus on the collaborative formulation of a comprehensive Cyberinfrastructure Plan for the WATer and Environmental Research Systems (WATER) network.

Multi-Scale Modeling (MSM): Multi-Scale Modeling is growing rapidly in the academic communities funded by NSF and the Engineering Directorate. The Chemical, Bioengineering Environmental and Transport Systems Division hosts the new interagency solicitation on MSM in Biomedical, Biological, and Behavioral (BBB) systems. The first MSM-BBB competition was completed in FY 2005, with four agencies (NSF, NIH, NASA, and DOE) investing nearly $20.0 million to support 24 MSM-BBB projects. A principal investigator meeting is being organized for FY 2006, and the next MSM-BBB competition is in planning for FY 2007.

Biology in Engineering: Biology in Engineering is one of the five priority areas established by the directorate, and is heavily supported by the division. CBET leads both the interagency solicitation on Metabolic Engineering, and the NSF inter-directorate (ENG, BIO, CISE, and MPS) solicitation on Quantitative Systems Biotechnology. CBET will continue to support large-scale activities such as the National Nanotechnology Infrastructure Network, Nanoscale Science and Engineering Centers, and a Science and Technology Center on New Materials for Water Purification.

Changes from FY 2006:

- The major change from FY 2006 is the merging of the BES and the CTS Divisions to form the Chemical, Bioengineering Environmental and Transport Systems Division.
- Combined with a reallocation of core research funds, support for the National Nanotechnology Initiative (NNI) increases by $2.89 million to a total of $42.82 million with an increased focus in the area of Nanoscale Interdisciplinary Research Teams.
- An increase of $5.0 million to support leading edge, frontier research across NSF on sensors and other research that is potentially relevant to the detection of explosives and related threats.

CIVIL, MECHANICAL AND MANUFACTURING INNOVATION $152,160,000

The FY 2007 Budget Request for the Civil, Mechanical and Manufacturing Innovation Division (CMMI) is $152.16 million, an increase of $5.37 million, or 3.7 percent, above the FY 2006 Current Plan of $146.79 million.

Civil, Mechanical and Manufacturing Innovation Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Civil, Mechanical and Manufacturing Innovation	**$141.13**	**$146.79**	**$152.16**	**$5.37**	**3.7%**
Major Components:					
Research and Education Grants	117.65	119.92	124.31	4.39	3.7%
Network for Earthquake Enginnering and Simulation (NEES)	17.94	20.31	21.27	0.96	4.7%
National Nanoscale Infrastructure Network (NNIN)	1.65	1.63	1.65	0.02	1.2%
Nanoscale Science and Engineering Centers (NSEC)	3.89	4.93	4.93	-	-

About CMMI:

The Civil, Mechanical and Manufacturing Innovation (CMMI) Division enables a globally competitive and sustainable future for the Nation by supporting fundamental research to advance the frontiers of knowledge. CMMI supports areas related to designing, building, and securing the Nation's critical infrastructure, and manufacturing and service enterprise. CMMI also invests in engineering education to foster a world-class engineering workforce. CMMI programs are organized into three clusters: Engineering Infrastructure Systems, Innovation Science and Decision Engineering, and Materials Transformation and Mechanics. These clusters will provide the knowledge to design and secure the Nation's infrastructure, and to grow our Nation's wealth-producing enterprises.

A major portion of the division's portfolio supports the George E. Brown, Jr. Network for Earthquake Engineering Simulation. NEES is a system of 15 experimental facilities located at universities across the United States, which work together via the NEESgrid cyberinfrastructure. This research facility addresses important challenges in earthquake and tsunami engineering research. Investments in fundamental research in these areas allowed NSF's Engineering Directorate to quickly send research teams to gather ephemeral data following Hurricane Katrina. This fundamental knowledge can now be used to design predictive systems to mitigate damage and loss of life from similar natural hazards.

CMMI's design, manufacture and service portfolio is the largest of the federal agencies that support fundamental research and discovery that is not product or mission driven. This has led to early investments in solid-modeling systems, optimization and network methods, and processes that provide solid representations directly from digital data, and enable engineered processes for growing tissue.

In general, 72 percent of the CMMI portfolio is available for new awards. The remaining 28 percent funds awards made in previous years.

CMMI Priorities for FY 2007:

- Manufacturing Frontiers by supporting research in the enabling processes, systems and enterprises to advance nanomanufacturing and the technology for healthcare delivery.

- Critical Infrastructure Systems by supporting research that leads to technologies for the protection, maintenance, or modification of the Nation's critical civil and cyberinfrastructure.
- Complexity in Engineered and Natural Systems by supporting research that leads to fundamental knowledge of complex systems and their modeling.
- In addition, CMMI will collaborate in advancing ENG's priority areas of: Biology in Engineering and New Frontiers in Nanotechnology.

A major priority is also support for NEES research, operations, and grand challenge research. As of October 2005, 25 research projects have been funded to utilize the NEES facilities. In FY 2007, research will involve experimental and theoretical simulations at the NEES facilities, addressing important challenges in earthquake and tsunami engineering research.

Looking toward the future, CMMI is engaged with its research community to focus its FY 2007 investment priorities. This includes two workshops jointly sponsored with NIH's National Institute for Biomedical Imaging and Bioengineering (NIBIB) on Healthcare Delivery; a workshop on fundamental research needs for the coastal states that potentially suffer from hurricanes, earthquakes and tsunamis; a workshop on research needs in nano-metrology, in collaboration with agencies that are part of the NSTC Interagency Working Group on Manufacturing R&D, to enable nano-enterprises; and, a World Forum to further expand NEES network linkages. In addition, CMMI will actively support an ENG-wide workshop on Complex Systems.

CMMI supports nanoscale science and engineering, with programs in the Materials Transformation and Mechanics' cluster on Nanomanufacturing and Nano/Bio-Mechanics. These programs have a critical role in converting discoveries into innovations, and are a key component of the Engineering Directorate's New Frontiers in Nanotechnology and the grand challenges for the National Nanotechnology Initiative. A range of manufacturing discoveries and innovations are needed to design the systems and processes to deliver products, devices and components that take advantage of the unique properties of the nanoscale. Simultaneously, an entirely new manufacturing workforce needs to be educated and trained in nanotechnology to bring to fruition the many exciting opportunities that nanotechnology has opened up. CMMI's nanomanufacturing program will continue to support 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.

Changes from FY 2006:

- The major change from FY 2006 is the merging of the Civil and Mechanical Systems and the Design and Manufacturing Innovation Divisions to form the CMMI Division.
- Combined with a reallocation of core research funds, support for the National Nanotechnology Initiative (NNI) increases by $1.92 million to a total of $28.38 million with an increased focus in the area of Nanoscale Interdisciplinary Research Teams (NIRT).
- An increase of $5.0 million to support leading edge, frontier research across NSF on sensors and other research that is potentially relevant to the detection of explosives and related threats.
- An increase of $6.0 million as a result of the transferring of resources from the EEC Division related to the phasing out of Earthquake Engineering Research Centers. These reallocated resources will be used to support research in the Engineering Infrastructure Systems cluster.
- An increase of $960,000 to a total of $21.27 million will continue to accommodate the operations and research phase for the Network for Earthquake Engineering Simulation (NEES).

ELECTRICAL, COMMUNICATIONS AND CYBER SYSTEMS $80,900,000

The FY 2007 Budget Request for the Electrical, Communications and Cyber Systems (ECCS) Division is $80.90 million, an increase of $3.63 million, or 4.7 percent, over the FY 2006 Current Plan of $77.27 million.

Electrical, Communications and Cyber Systems Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Electrical, Communications and Cyber Systems	**$70.79**	**$77.27**	**$80.90**	**$3.63**	**4.7%**
Major Components:					
Research and Education Grants	59.76	65.65	69.19	3.54	5.4%
Nanoscale Science and Engineering Centers (NSEC)	2.48	3.16	3.16	-	-
National Nanoscale Infrastructure Network (NNIN)	4.55	4.50	4.55	0.05	1.1%
Science and Technology Center (STC)	4.00	3.96	4.00	0.04	1.0%

About ECCS:

The Electrical, Communications and Cyber Systems (ECCS) Division will address fundamental research issues underlying component and device technologies, power, controls, networking, communications and cybersystems technologies. The division will also support the integration and networking of intelligent systems at the nano, micro and macro scales for a variety of applications in healthcare, homeland security, disaster mitigation, energy, telecommunications, environment, transportation, manufacturing, and other systems-related areas. ECCS envisions a research community that will address major technological challenges for the next generation of devices and systems due to convergence of technologies and increased emphasis on interdisciplinary research. One of the goals of the division is the integration of education into programs to support the education of a diverse workforce in the 21st century that will continue innovative advances for the rapid development of emerging technologies as drivers of the global economy.

In general, 81 percent of the ECCS portfolio is available for new awards; the remaining 19 percent funds awards made in prior years.

ECCS will be organized around three programs that will focus on research and educational issues involving device and component technologies, network technologies, and systems engineering: Electronics, Photonics and Device Technologies (EPDT); Power, Controls and Adaptive Networks (PCAN); and Integrative, Hybrid and Complex Systems (IHCS).

ECCS Priorities for FY 2007:

The Electronics, Photonics and Device Technologies program will seek to improve the fundamental understanding of devices and components based on the principles of electronics, photonics, magnetics, electro-optics, electromechanics, and related physical phenomena. The program will continue to invest in advancing the frontiers of spin electronics, molecular electronics, bioelectronics, nonsilicon electronics, flexible electronics, photonics, optoelectronics, power electronics, and microwave and mixed signal devices. EPDT will further support related topics in quantum engineering, revolutionary electromagnetic materials-based device solutions, radio frequency integrated circuits, and reconfigurable antenna for telecommunications, telemedicine and other wireless applications. ECCS will enable discovery and innovation through new approaches to electronics, beyond the scaling limits of complementary metal oxide semiconductor technology.

The Power, Controls and Adaptive Networks program will invest in the design and analysis of intelligent and adaptive engineering networks including sensing, imaging, controls and computational technologies for a variety of application domains. PCAN will further invest in adaptive dynamic programming, reinforced learning, pattern recognition, and intelligent agents to develop brain-like networked architectures performing real-time learning, computational video and imaging, and embedded control of robotics. Strong emphasis will be placed on critical infrastructure aspects of electric power networks and grids, including generation and integration of renewable, sustainable and distributed energy systems into large power networks, high power electronics and drives, and understanding of associated regulatory and economic structures.

The Integrative, Hybrid and Complex Systems program is intended to spur visionary systems-oriented activities in collaborative research and education environments. IHCS will support innovative research that integrates physical devices and components with computational intelligence and networks in design, development and implementation of new nano/micro/macro complex and hybrid systems with engineering solutions for a variety of domain-specific applications. IHCS will also support integration technologies at the intra- and inter-chip levels, and advanced RF/wireless and optical communications systems.

Emphasis in the IHCS program also will be on the support and development of innovative hardware/software architectures for emerging areas of cyberengineering and cybersystems. Research in cyberengineering systems will support activities that will integrate physical devices with distributed sensing and actuation, communications, storage, computation and control of complex systems; focus on design, integration and implementation of multi-scale and multi-level complex systems; and enable visualizing, analyzing and reconfiguring of complex systems due to emergent behavior to develop reliable and agile infrastructures for domain-specific applications. Some examples include, but are not limited to: multi-scale dynamic system integration for real-time monitoring and control of engineered complex and hybrid systems; self-organizing blackout-free electric power grid; ambient intelligent systems' networks for homes of the future; computer-integrated telemedicine and robotic surgical systems; and a globally interactive environment for engineering education.

The strategic development of ECCS programs in research and education will continue to support NSF three multidisciplinary priority areas. ECCS will continue to provide support for specialized resources and infrastructure that facilitate research and educational activities, including the NNIN, STC, NSEC and NSEE centers, as well as crosscutting activities, such as the WATERS network.

ECCS will support the development of people through Foundation-wide programs, such as CAREER and ADVANCE, and through REU and RET supplements, and will actively participate in the development and management of cross-disciplinary programs. ECCS plans to continue to support Graduate Research Supplements (GRS) to broaden participation of underrepresented Ph.D. students majoring in electrical engineering. ECCS will hold grantees' workshops to assess the results of research and education grants and focused workshops to assess research and technology areas of current and future importance.

Changes from FY 2006:

- Combined with a reallocation of core research funds, support for the National Nanotechnology Initiative (NNI) increases by $2.61 million to a total of $38.56 million with an increased focus in the area of Nanoscale Interdisciplinary Research Teams.
- An increase of $5.0 million to support leading edge, frontier research across NSF on sensors and other research that is potentially relevant to the detection of explosives and related threats.

INDUSTRIAL INNOVATION AND PARTNERSHIPS $120,080,000

The FY 2007 Budget Request for the Industrial Innovation and Partnerships (IIP) Division is $120.08 million, an increase of $9.52 million, or 8.6 percent, over the FY 2006 Current Plan of $110.56 million.

Industrial Innovation and Partnerships Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Industrial Innovation and Partnerships	**$113.10**	**$110.56**	**$120.08**	**$9.52**	**8.6%**
Major Components:					
Small Business Innovation Research (SBIR)	91.96	89.84	97.47	7.63	8.5%
Small Business Technology Transfer (STTR)	10.79	10.52	11.41	0.89	8.5%
Grant Opportunities for Academic Liaison with Industry (GOALI)	3.10	3.40	4.40	1.00	29.4%
Industry/University Cooperative Research Centers (I/UCRS)	7.25	6.80	6.80	-	-

About IIP:

The newly created Industrial Innovation and Partnerships Division (IIP) serves the entire foundation by fostering partnerships to advance technological innovation. The division manages the two congressionally mandated small business research programs: the Small Business Innovation Research program; and, the Small Business Technology Transfer program. IIP also manages the Partnerships for Innovation (PFI) program, which stimulates innovation by building partnerships across the scientific and engineering community. In addition, the IIP leverages industrial support through two research programs: Grants Opportunities for Academic Liaison with Industry; and Industry/University Cooperative Research Centers.

Twice each year, SBIR and STTR release their proposals solicitation topics. These solicitations cover technologies that emphasize innovation with commercialization potential. From the business community perspective, SBIR/STTR investments are considered “pre-seed,” that is, they support research that is considered too high-risk for even early stage corporate investment. The research topics in the SBIR/STTR solicitations are grouped into three business opportunity areas. These topics are designed to meet the needs of capital/investment markets, strategic partners, and national and societal priorities. They also have the potential to encourage business investments outside of the SBIR/STTR program.

The Grant Opportunities for Academic Liaison with Industry program enables partnerships between industry and academe where there is a common intellectual and educational agenda. The program supports (a) faculty, postdoctoral fellows, and students to conduct research and gain experience in an industrial setting; (b) industry scientists and engineers to bring industrial perspective and integrative skills to academe; and (c) interdisciplinary university/industry teams to conduct long-term projects. The program targets high-risk and high-gain research, with focus on fundamental topics that would not otherwise have been undertaken by industry; the development of innovative, collaborative university/industry educational programs; and the direct exchange of new knowledge between academe and industry.

The Industry/University Cooperative Research Centers program develops long-term partnerships among industry, academe, and government. The centers are catalyzed by a small investment from NSF, and are primarily supported by industry center members, with NSF taking a supporting role in their development and evolution. Each center is established to conduct research that is of interest to both the industry and the center. An I/UCRC contributes to the Nation's research infrastructure base and enhances the intellectual capacity of the engineering and science workforce through the integration of research and education.

In general, 96 percent of the IIP portfolio is available for new awards. The remaining 4 percent funds awards made in previous years.

IIP Priorities for FY 2007:
Within the SBIR/STTR research topics, Biotechnology, Information Technology, and Electronics Technology are positioned as potentially attractive to the venture capital and “angel network” communities. Advanced Materials and Manufacturing and Chemical Technology research topics are of interest to the large corporations that see the potential for strategic partnerships with the small business community. Selected topics are launched in response to national priorities such as Manufacturing Innovation and Security Technology. To accelerate near term technological innovation, a special topic, Emerging Opportunities, was launched in 2006, and will be continued into FY 2007. SBIR/STTR will explore innovation research opportunities with potential for countermeasure to improvised explosive devices (IED). In FY 2006, SBIR and STTR programs expect to reverse the downward trend in funding rate, which bottomed at 10 percent for SBIR/STTR Phase I proposals in 2004-2005. Highly qualified small business innovation research proposals remained unfunded. Release of focused solicitation topics is reversing the trend. With increased funding in FY 2007, the target is to achieve 20 percent funding rate. IIP is poised to integrate and act on salient recommendations from upcoming studies by the National Academies as well as an OMB analysis of PART (Program Assessment Rating Tool).

An ENG strategy is to increase partnerships between academic and industrial communities. GOALI is well positioned to directly impact this objective through leveraging its $4.40 million budget – with support from other academic research programs – by a factor of four-to-one. In FY 2007, to further build collaboration across academic programs and to increase academic and industrial partnerships, the GOALI program budget will increase by $1.0 million above the FY 2006 Current Plan of $3.40 million. This 30 percent increase in budget is consistent with and supportive of ENG’s goal for this program.

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 innovate new products and services. The I/UCRC program provides modest seed funds and management expertise to these highly leveraged centers, with states joining in many partnerships to expand the centers’ activities to have an impact on local economic development. In FY 2006, I/UCRC is launching a supplemental research initiative to advance the underlying fundamental science and technology of the centers. FY 2007 funding will continue to strengthen the technology base of centers supported by this program.

Changes from FY 2006:

- Increase of $7.63 million, to a total of $97.47 million for the Small Business Innovation program.
- Increase of $890,000, to a total of $11.41 million for the Small Business Technology Transfer program.
- Increase of $1.0 million, to a total of $4.40 million for GOALI program.

ENGINEERING EDUCATION AND CENTERS $125,970,000

The FY 2007 Budget Request for the Engineering Education and Centers (EEC) Division is $125.97 million, an increase of $2.54 million, or 2.1 percent, from the FY 2006 Current Plan of $123.43 million.

Engineering Education and Centers Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Engineering Education and Centers	**$120.01**	**$123.43**	**$125.97**	**$2.54**	**2.1%**
Major Components:					
Research and Education Grants	39.91	41.18	50.35	9.17	22.3%
Engineering Research Centers (ERC)	62.31	63.42	62.79	-0.63	-1.0%
Earthquake Engineering Research Centers (EERC)	6.00	6.00	-	-6.00	-100.0%
Nanoscale Science and Engineering Centers (NSEC)	8.44	9.48	9.48	-	-
Network for Computational Nanotechnology	3.35	3.35	3.35	-	-

About EEC:

The Engineering Education and Centers (EEC) Division promotes and facilitates university research and curricula by supporting innovative programs that integrate research and education, improve the quality of the engineering workforce, cut across disciplines, and whose breadth of investigation spans from idea inception to proof-of-concept. The division's programs are divided into three major categories: development of interdisciplinary research centers that foster partnerships between academe, government and industry; advancing graduate and undergraduate engineering education; and development of a diverse and capable technical workforce. EEC programs address issues that are critical to all fields of engineering and benefit from a centralized management focus, as well as complement the research and education portfolios of the other divisions of the Engineering Directorate. Included 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 general, 70 percent of the EEC portfolio is available for new awards; the remaining 30 percent funds awards made in previous years.

EEC Priorities for FY 2007:
In FY 2007, EEC will provide support for Engineering Research Centers, Nanoscale Science and Engineering Centers, engineering education research, and engineering workforce development. Approximately 65 percent of the EEC budget supports center related activities, with the remaining 35 percent supporting engineering education and workforce development programs.

In FY 2006, eighteen Engineering Research Centers were funded. A sample would reveal research and develop of, sensory prostheses that interface to the human nervous system, systems for detection of and warning of severe storms, computer-integrated surgical systems, biomaterials for implants, reconfigurable manufacturing systems, and power electronics. In FY 2006, five new ERCs are being added to the portfolio, enabled by funds released into the ERC program through the graduation to self-sufficiency of five ERCs in FY 2005, and phasing down support to seven ERCs during FY 2005 and 2006 to prepare them for self-sufficiency.

The eight 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. They involve key partnerships with industry, national laboratories, and other sectors; and support education programs from the graduate to the pre-college level designed to develop a highly skilled workforce. Funds are also provided to smaller interdisciplinary teams and to the Network for Computational Nanotechnology, a web-accessible repository of simulations of nanoscale phenomena for research and education. Funding for the ERCs will see a slight decrease during FY 2007, which will result in small percentage reductions across all the Centers.

EEC programs in engineering education are aimed at transforming engineering education to produce an engineering workforce that is diverse and creative, understands the impacts of its solutions on both technical and social systems, and possesses the ability to adapt to the rapidly evolving technical environment in industry, academe, and society. In FY 2007, research will be supported that contributes to our basic understanding of how students learn engineering. Significant breakthroughs in understanding are sought so that our undergraduate and graduate engineering education can be transformed to meet the needs of the changing economy and society. Topics of particular interest include: the aims and objectives of engineering education, the content and organization of the curriculum, how students learn problem solving, creativity and design, new methods for assessment and evaluation of how students learn engineering, and research that helps us understand how to attract a more talented and diverse student body to all levels of engineering study

Existing programs in Research Experiences for Undergraduates (REU) Sites and Research Experiences for Teachers (RET) Sites, which have been shown to be successful programs for broadening participation in engineering programs at both the undergraduate and graduate levels will continue in FY 2007 with a small increase in their levels.

Changes from FY 2006

- Support for the National Nanotechnology Initiative (NNI) increases by $1.83 million, to a total of $25.23 million with an increased focus in the area of Nanoscale Interdisciplinary Research Teams.
- An increase of $5.0 million to support leading edge, frontier research across NSF on sensors and other research that is potentially relevant to the detection of explosives and related threats.
- Support for the REU Sites program increases by $100,000, to a total of $8.60 million.
- Funding for the RET Sites program increases by $100,000, to a total of $4.10 million.
- Support for the GK-12 program increases by $180,000, to a total of $3.37 million.
- Support for unsolicited engineering education projects increases by $1.99 million to a total of $13.02 million.
- Funding for ERCs decreases by $630,000, to a total of $62.79 million resulting in a slight decrease of support for outreach supplements at each center.
- $6.0 million is reallocated to the Civil, Mechanical and Manufacturing Innovation (CMMI) Division. Funding for three earthquake engineering centers ended in FY 2006. These centers awarded in FY 1997 were a part of the National Earthquake Hazards Reduction Program (NEHRP) and helped to highlight the Nation's need for the Network for Earthquake Engineering Simulation (NEES).

EMERGING FRONTIERS IN RESEARCH AND INNOVATION $25,000,000

The FY 2007 Budget Request for the Office of Emerging Frontiers in Research and Innovation (EFRI) is $25.0 million. This is a new budget line in FY 2007.

Emerging Frontiers in Research and Innovation Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Emerging Frontiers in Research and Innovation	**-**	**-**	**$25.00**	**$25.00**	**N/A**

About EFRI:

The Office of Emerging Frontiers in Research and Innovation (EFRI) is a new component of the Directorate for Engineering. It will serve the critical role of helping the directorate focus on important emerging areas in a timely manner. Each year, beginning in FY 2007, EFRI will do this by annually recommending, prioritizing, and funding interdisciplinary initiatives at the emerging frontier of engineering research and education.

This emerging frontier research is frequently found in high-risk, interdisciplinary areas. The divisions within the NSF's Engineering Directorate are not strategically aligned to support this type of research, which often falls outside the usual classifications and research areas. EFRI will enable ENG to pursue these interdisciplinary areas by allowing the engineering community to come forward with new, and hopefully paradigm-shifting proposals at the interface of disciplines and fields. This Office will have the potential to push the frontier in new and emerging areas.

Technological innovations, particularly over the past decade, have given rise to new industries, expanded our access to quality healthcare, and fueled our Nation's prosperity even in the face of growing global competition. Now that global competition is increasing, the technical underpinnings of the past may not be adequate to ensure our continued success. EFRI will provide critical, strategic support of fundamental discovery, especially in areas leading to breakthrough technologies.

The Office also will enable the Engineering Directorate to focus resources on engineering grand challenges. These challenges may include areas such as safe, clean water; sustainable energy resources; technologies to overcome physical limitations from disease or injury; and integrated systems designed to thwart attacks on U.S. interests throughout the world. EFRI will have the necessary flexibility to target our long-term challenges, while retaining the ability to adapt as new challenges demand. In general, 100 percent of the portfolio is available for new awards.

EFRI Priorities for FY 2007:

The role of the Office of Emerging Frontiers in Research and Innovation is to fund research opportunities that would be difficult to fund with current mechanisms, such as Small Grants for Exploratory Research, typical core awards, or large research center solicitations. EFRI support will represent transformative opportunities with high potential payoff leading to: new research areas for NSF, ENG, and other agencies; new industries or capabilities that result in a leadership position for the country; and/or significant progress on a recognized national need or grand challenge. The successful topics would likely require small- to medium-sized interdisciplinary teams of researchers with significant funding, for a period of time needed to make substantial progress that would provide evidence for additional follow-on funding through other established funding mechanisms.

Mechanisms:

Potential EFRI topics can arise from a number of sources – the community, ENG leadership, workshops, professional societies, academies, proposals and awards. Yet, in the case of directed specified topics, the ENG program directors will play the central role within NSF.

The Office of Emerging Frontiers in Research and Innovation will operate by the following process:

- At the beginning of each calendar year, NSF program directors will propose frontier research areas that show potential for significant growth or transformative results.
- Program directors will then prioritize these topical areas, which will be reviewed by the ENG leadership.
- Based on the prioritized list of topics, working groups will generate proposed announcements.
- These will be presented as recommendations to the ENG Advisory Committee for feedback at their spring meeting.
- Based on this feedback, the ENG leadership will evaluate the recommendations and make the final EFRI allocation decisions.
- These decisions will be the foundation of EFRI Solicitations and/or Dear Colleague Letters, which will go through the appropriate NSF preparation and clearance processes.

Potential EFRI topics will be evaluated against criteria such as: Does the topic represent an opportunity for a significant leap or paradigm shift in a research area, or have the potential to create a new research area? Is there potential for making significant progress on a current national need or grand challenge? Is the financial and research scope beyond the capabilities of one division? Is the community able to organize and effectively respond?

Topics:

EFRI research in FY 2007 will better enable the Engineering Directorate to meet NSF's strategic goal of fostering frontier research. Topics for EFRI support will mirror the five key frontier research areas identified during ENG's recent strategic-planning process. These are: *Biology in Engineering,* which covers research at the critical interface between engineered and biological systems; *Complexity in Engineered and Natural Systems,* where a system yields unexpected, emergent properties; *Critical Infrastructure Systems,* which encompasses research on how our national infrastructures can withstand threats and meet future demands; *Manufacturing Frontiers,* where device innovations help ensure U.S. leadership in a global marketplace; and *New Frontiers in Nanotechnology,* which applies our current fundamental knowledge of the nanoscale in new and innovative directions.

These frontier research areas will guide the decision-making process throughout the ENG Directorate, but specifically within the Office of Emerging Frontiers in Research and Innovation. The EFRI Office will identify and prioritize emerging frontier areas of research and education, and provide resources for pursing these priorities.

Changes from FY 2006: The major change for FY 2007 is the creation of the Office of Emerging Frontiers for Research and Innovation within the Engineering Directorate. A portion of the overall ENG increase combined with reallocations from the ENG Divisions provide the funding for EFRI.

GEOSCIENCES $744,850,000

The FY 2007 Budget Request for the Directorate for Geosciences (GEO) is $744.85 million, an increase of $42.02 million, or 6.0 percent, over the FY 2006 Current Plan of $702.83 million.

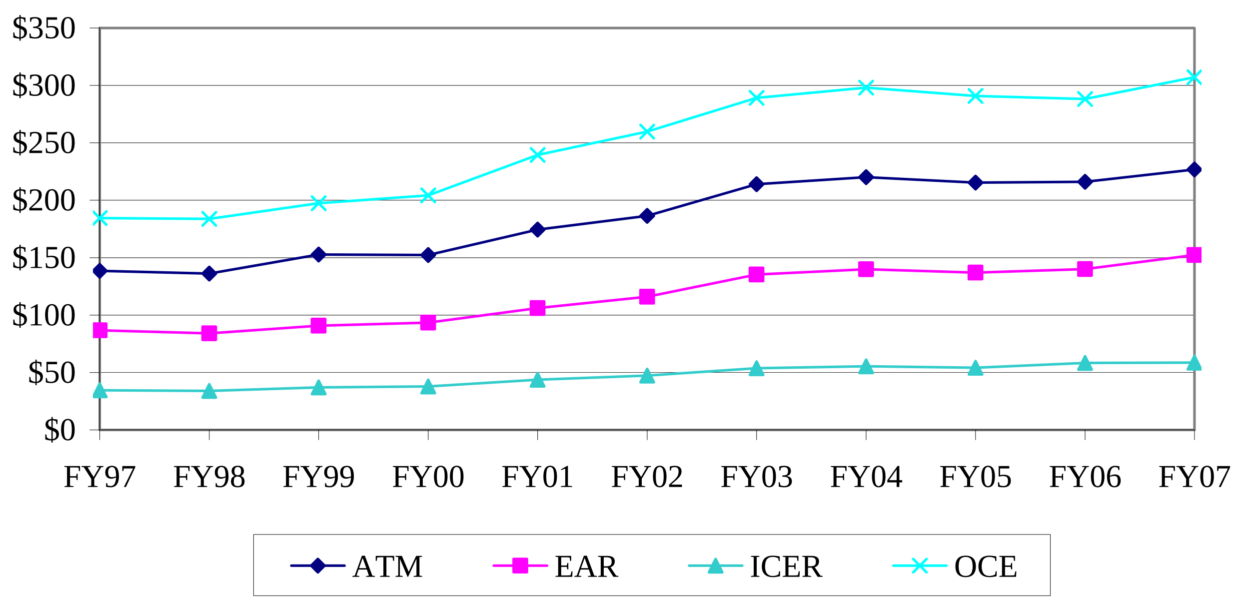
Geosciences Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Atmospheric Sciences (ATM)	215.32	216.09	226.85	10.76	5.0%
Earth Sciences (EAR)	136.95	140.12	152.30	12.18	8.7%
Innovative & Collaborative Education and Research (ICER)	54.11	58.37	58.57	0.20	0.3%
Ocean Sciences (OCE)	290.79	288.25	307.13	18.88	6.5%
Total, GEO	$697.17	$702.83	$744.85	$42.02	6.0%

Totals may not add due to rounding.

The Directorate for Geosciences (GEO) supports research, infrastructure, and education in the atmospheric, earth, and ocean sciences needed to advance our understanding of the integrated Earth system.

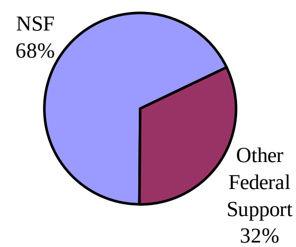
GEO Subactivity Funding
(Dollars in Millions)



RELEVANCE

GEO supports basic research that contributes to a better understanding of the many processes that affect the global environment such as the role of the atmosphere and oceans in climate, the planetary water cycle, and the relative importance of natural variability and the effects of increased concentrations of greenhouse gases in the atmosphere. Support is provided for interdisciplinary studies that contribute directly to national research priorities: hydrologic systems, biogeochemical dynamics, ecological systems and dynamics, solid earth processes, and solar influences on the Earth system. Lives are saved and property is preserved through better prediction and understanding of natural environmental hazards such as earthquakes, tornadoes, hurricanes, and tsunamis. Basic research supported by the Directorate for Geosciences enables preparation for and subsequent mitigation of the effects of these and other inevitable natural events. 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, consistent with the Administration's priorities for research and development.

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 68 percent of the total federal support in these areas. Not only does GEO play a critical role in addressing the nation's need to understand, predict, and respond to environmental events and changes, but also helps to determine the best use of Earth's resources. Fundamental research in the geosciences advances scientific knowledge of resources such as fresh water, energy, minerals, and biological diversity, leading to improved future quality of life. Activities supported by GEO are well aligned with the Administration's research and development priorities, including investments in high-end computing and nanotechnology. GEO investments include many environmental studies coordinated through the U.S. Climate Change Science Program. GEO-supported activities contribute to national and global observational capabilities and research infrastructure for land, ocean, and atmospheric processes.

Summary of Major Changes by Division *(Dollars in Millions)*

GEO FY 2006 Current Plan ……………………………….…………………………….........$702.83

Atmospheric Sciences (ATM) +10.76

Increased support will target the following areas: the operation of the High-performance Instrumented Platform for Environmental Research (HIAPER), which sees its first full year of operation in FY 2007; the operation of the Advanced Modular Incoherent Scatter Radar (AMISR); support for a new Science and Technology Center, the Center for Atmospheric Process Modeling; and improved cyberinfrastructure and numerical models that will allow new discoveries, greater access to atmospheric data, and improved understanding of the atmospheric environment.

Earth Sciences (EAR) +$12.18

Increased funding focuses on operational and scientific support of the EarthScope facility, which is being constructed through the MREFC account, and improving the cyberinfrastructure available to earth scientists.

Innovative & Collaborative Education and Research (ICER)	+$0.20
In FY 2007, support for international collaborative activities will increase slightly after several years of level funding.	
Ocean Sciences (OCE)	+$18.88
Areas receiving increased funding support include developmental activities related to the Ocean Observatories Initiative, operation of the academic research fleet, and development of advanced ocean research cyberinfrastructure.	
Subtotal, Changes	+$42.02

GEO FY 2007 Request ……………………………………………………………...…….$744.85

Summary of Major Changes by Directorate-wide Investments

GEO FY 2006 Request ………………………………..………………………………..............$702.83

Advancing the Frontier

Disciplinary and Interdisciplinary Research	+$19.74
Support for research activities across the geosciences will increase, resulting in about 65 additional research grants and maintaining present funding rates.	
Science and Technology Centers	+$8.00
The Center for Atmospheric Process Modeling at Colorado State University and the Center for Coastal Margin Observation/Prediction at the Oregon Health and Science University were selected in the FY 2005 STC competition. Initial FY 2006 funding is through Integrative Activities; FY 2007 funding is through GEO at $4.0 million for each STC.	

Education and Workforce

Enhancing K-12 Education	+$0.47
GEO will expand support for the successful network of Centers for Ocean Science Education Excellence.	

Facilities and Infrastructure

Academic Research Fleet	+$4.50
GEO is the primary supporter of operations of the national academic research fleet. Overall, operational support is projected to increase by $4.50 million or about 6 percent enabling continued operation of the fleet at approximately the same level as in FY 2006.	
In addition, several augmentations and acquisitions are underway to improve the capability of the fleet. These include: acquisition of the first in a planned series of Regional-class Research Vessels (+$11.50 million to a total of $15.10 million) to replace aging and less capable ships, development and construction of a next-generation human-occupied research submersible to replace the aging A.L.V.I.N. (-$400,000 to a total of $5.10 million), and the completion in FY 2006 of outfitting a newly-acquired seismic research vessel.	

Advanced Modular Incoherent Scatter Radar (AMISR) Construction of AMISR is scheduled to be completed in FY 2006. Operation is supported at a level of $2.70 million.	-$8.00
EarthScope Operation Operational support of the EarthScope facility being constructed through the MREFC account is supported at a level of $11.61 million in FY 2007, enabling full operation of completed facility elements.	+$4.89
Ocean Drilling Activities The Integrated Ocean Drilling Program, including operation of a new Scientific Ocean Drilling Vessel acquired and outfitted with support from the MREFC account, will decrease by $3.20 million to a total of $25.80 million. This reduction reflects the decrease in anticipated ship operation support required during the vessel conversion activities being supported through the MREFC account.	-$3.20
Ocean Observatories Support for activities to prepare for the Ocean Observatories Initiative, one of GEO's contributions to the Global Earth Observation Systems of Systems (GEOSS) and proposed as a new MREFC start in FY 2007, will increase by $3.10 million to a total of $8.30 million. This will finalize developmental work in advance of the beginning of the construction phase of the project requested in the MREFC section of this document.	+$3.10
National Center for Atmospheric Research (NCAR) Research activities across the National Center for Atmospheric Research will increase by $3.49 million, or by about 3.0 percent.	+$3.49
Net, all other program changes	+$9.03
Subtotal, Changes	+$42.02
GEO FY 2007 Request ……………………………………………………………………..	**$744.85**

NSF-WIDE INVESTMENTS

In FY 2007, the Directorate for Geosciences will support research and education efforts related to broad, Foundation-wide investments in a number of areas including NSF's three multidisciplinary Priority Areas; the Administration's four interagency R&D priorities; and other priorities of high and specific interest to the Administration.

GEO NSF-wide Investments
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Percent
Biocomplexity in the Environment	$37.22	$36.85	$26.11	-$10.74	-29.1%
Human and Social Dynamics	1.35	1.35	1.35	-	-
Mathematical Sciences	7.07	7.00	3.53	-3.47	-49.6%
Climate Change Science Program	150.35	149.35	157.72	8.37	5.6%
Cyberinfrastructue	71.35	71.35	75.00	3.65	5.1%
International Polar Year	-	-	5.00	5.00	N/A
National Nanotechnology Initiative	7.94	9.00	9.65	0.65	7.2%
Networking and Information Technology R&D	14.56	14.56	14.56	-	-

Biocomplexity in the Environment: Consistent with plans to phase out the Biocomplexity priority area after FY 2007, GEO will support 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. In FY 2007 the second year of a special focus on integrated natural cycles will be supported, as will the second year of support for an emphasis on coupled natural and human systems.

Human and Social Dynamics: GEO continues funding of $1.35 million to engage the social science community in understanding and predicting behavior in response to extreme events (earthquakes, tsunamis, hurricanes, tornadoes, solar disruptions, etc.) and other natural processes affecting society.

Mathematical Sciences: 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 $3.53 million. This 49.6 percent reduction from the FY 2006 Current Plan is consistent with plans to transfer the activities of the priority area after FY 2007 into the core.

Climate Change Science Program (CCSP): GEO leads NSF efforts in the interagency CCSP to enhance understanding of the dynamics among natural and human systems, generate the knowledge needed to preserve, manage, and enhance the environment, as well as to support national and international policy-making activities. Specific activities include programs focused on understanding past climate variability, elucidating how carbon and nitrogen cycle through the earth, atmosphere and oceans, and efforts to develop and refine computational models of earth system processes.

Cyberinfrastructure: Research advances in the geosciences increasingly depend on the presence of underlying cyberinfrastructure to bridge systems and make data interoperable across platforms. In FY 2007, GEO will continue to invest aggressively in the cyberinfrastructure required to maintain the pace of discovery in the geosciences.

International Polar Year (IPY): As part of NSF's IPY activities, GEO will focus on modeling in the polar regions, including ocean currents, climate, and extent of sea ice coverage. Also, research activities associated with the Integrated Ocean Drilling Program are planned in the Arctic during FY 2007.

Networking and Information Technology R&D (NITRD): Within NITRD, GEO focuses on the development and enhancement of computational modeling capacity and capability. One flagship activity is the Climate Simulation Laboratory at the NCAR, located in Boulder, CO, which serves a broad community of researchers utilizing advanced computational techniques to model atmospheric processes ranging from projections of future climate to forecasting hurricane intensity and landfall.

National Nanotechnology Initiative (NNI): GEO contributions to NNI include studies of natural nanoscale processes in the environment and utilizing nanoscale phenomena as catalysts for environmental remediation.

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 76 percent in FY 2005, 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. If included, the merit-reviewed share of GEO funding would rise to 87 percent.

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 broad range of academic institutions and industry; broad geographic representation; and balanced representation of women and under-represented minorities.

PERFORMANCE

NSF's FY 2007 budget is also aligned to reflect funding levels associated with the Foundation's four strategic outcome goals and the ten investment categories highlighted in the FY 2003-2008 Strategic Plan. These categories were designed as a mechanism to better enable assessment of program performance and to facilitate budget and performance integration.

Geosciences

By Strategic Outcome Goal and Investment Category

(Dollars in Millions)

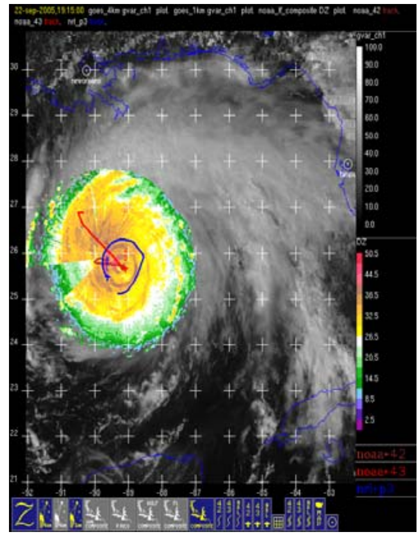
	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Ideas					
Fundamental Science and Engineering	350.70	351.08	370.32	19.24	5.5%
Centers Programs	10.69	10.58	18.68	8.10	76.6%
Capability Enhancement	-	-	-	-	N/A
	361.39	361.66	389.00	27.34	7.6%
Tools					
Facilities	154.98	148.91	158.80	9.89	6.6%
Infrastructure and Instrumentation	60.12	64.02	64.85	0.83	1.3%
Federally-Funded R&D Centers	81.54	83.94	87.43	3.49	4.2%
	296.64	296.87	311.08	14.21	4.8%
People					
Individuals	27.02	27.90	27.90	-	-
Institutions	3.50	3.46	3.46	-	-
Collaborations	4.53	7.53	8.00	0.47	6.2%
	35.05	38.89	39.36	0.47	1.2%
Organizational Excellence	4.09	5.41	5.41	-	-
Total, GEO	$697.17	$702.83	$744.85	$42.02	6.0%

Totals may not add due to rounding.

GEO will continue its commitment to education, training, and increasing diversity in FY 2007. The FY 2007 budget will maintain award size and continue to focus on multidisciplinary research activities, inter-agency partnerships, and international activities with special attention given to broadening participation at all levels. In addition, development of new infrastructure remains a priority, with ongoing support for the acquisition of new regional research vessels and increased support for the operation of the EarthScope facility being constructed through the MREFC account.

Recent Research Highlights

► A New Tool to Better Predict Hurricane Intensity:
Hurricanes Katrina and Rita caused incalculable misery and devastation throughout the Gulf Basin area, but data gathered by the Hurricane Rainband and Intensity Change Experiment (RAINEX) could lead to much more effective strategies for mitigating such damage in the future. RAINEX, which is jointly sponsored by NSF and the National Oceanic and Atmospheric Administration, flew multiple aircraft through both Katrina and Rita as the storms approached landfall in August and September of 2005. The research planes were able to take wind, pressure, moisture and temperature readings in different parts of the hurricanes at the same time, allowing researchers to form a complete picture of how the storms developed. A main focus of RAINEX has been to study how the rainbands and eyewalls interact to affect storm intensity.



Hurricane Rita, shown in a visible satellite image with Doppler radar overlay, on September 22, 2005. Three aircraft simultaneously sampled the inner structure of the hurricane, including the primary and secondary concentric eyewalls. The three solid colored lines represent aircraft tracks.

► Nanoparticles in the Real World: Many people associate nanoparticles – objects on the scale of atoms or molecules – with artificial creations in the new fields of nanoscience and nanotechnology. But some nanoparticles are created and exist naturally in the air, water, and soil. Jillian Banfield, Professor of Earth and Planetary Science at the University of California – Berkeley, studies nanoparticles that form in the environment through processes such as the weathering of rocks or the formation of tiny mineral clusters by microbes. Nanoparticles can be highly reactive and may provide ideal transportation for toxic metals and other contaminants passing through the environment. Fundamental questions about how these natural nanoparticles form, their structure, and their role in environmental processes remain to be answered. In her studies, Dr. Banfield has learned many of the details about how particle size influences the way ions are attached to and incorporated into crystalline minerals. Understanding these processes could lead to more effective and cleaner methods of manufacturing and energy production. Nanotechnology could also help develop the microscopic sensors needed to understand complicated fine-scale interactions between biological and inorganic substances in the environment.

Dr. Fred Sundberg and another earth science teacher examine electronic rain gauge. *Credit: The Najavo County Star January 2006*

► Saturday Scientists: Thanks to support from an NSF program, high-school students in Arizona can conduct real, hands-on primary research. Fred Sundberg's earth science students spend their Saturdays in the field constructing and maintaining silt fences to collect erosion runoff, analyzing rain data and soil samples, and surveying and analyzing vegetation in the course of conducting experiments to determine if logging activity on burned areas increases soil erosion. Sundberg's innovative class project lets students experience being earth scientists. They completely run the project and maintain and post their results on a website. Even the "project manager" is a student. Similar to any project manager, his or her responsibilities include managing resources, delegating tasks, maintaining a time schedule, and developing the final report for the client agencies.

► **Can that Buoy Hear You?** NSF-supported researchers recently developed and successfully deployed a novel, buoy-based ocean observatory that uses acoustic communication to wirelessly retrieve data from sensors at various depths in the water and on the seafloor. The system offers exciting new opportunities to monitor both episodic events and long-term changes in the oceans. For 13 months, this system was deployed off Vancouver Island in the Northeast Pacific to study a seep area (where underground fluids emerge) along the Nootka fault.

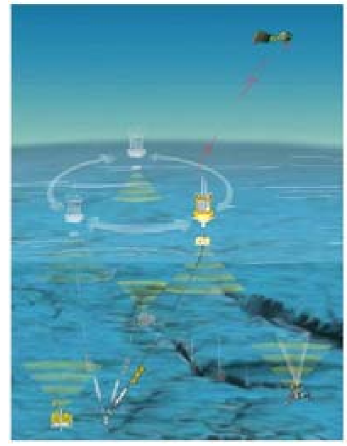


Diagram showing acoustically-linked moored buoy observatory deployed at the Nootka fault for 13 months in 2004-2005, recording data from an ocean bottom seismometer (lower left) and a suite of hydrothermal sensors (lower right). This system uses acoustic modems to send data from the seafloor to a surface buoy, and from the buoy to shore via an Iridium satellite link.

Equipped with a satellite link, the buoy system can provide near-real-time data, is easily expandable to accommodate additional sensors, and is fitted with two-way communication capabilities that enable sensors to be controlled from shore. This platform vastly increases the potential for observing periodic events, such as earthquakes, volcanic eruptions, and phytoplankton blooms, as well as changing ocean conditions over seasons and years, or during times of the year when measurements from shipboard platforms are simply not possible because of weather and other factors. Advanced ocean observation technology such as this is leading to a new era of exploration in the world's oceans.

Other Performance Indicators

The tables below show the number of people benefiting from GEO funding, and trends in award size, duration, number of awards, and funding rates.

Number of People Involved in GEO Activities

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Request
Senior Researchers	4,016	4,000	4,200
Other Professionals	2,549	2,550	2,700
Postdoctorates	557	550	600
Graduate Students	2,153	2,150	2,300
Undergraduate Students	1,171	1,200	1,300
Total Number of People	10,446	10,450	11,100

GEO Funding Profile

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Request
Statistics for Competitive Awards:			
Number	1,321	1,300	1,350
Funding Rate	28%	27%	28%
Statistics for Research Grants:			
Number of Research Grants	1,002	1,000	1,050
Funding Rate	25%	24%	25%
Median Annualized Award Size	$116,337	$116,500	$117,000
Average Annualized Award Size	$147,857	$148,000	$149,000
Average Award Duration, in years	3	3	3

Changes in Budget Structure

The Geosciences Activity is restructured in FY 2007 to include an additional subactivity, Integrative & Collaborative Education and Research (ICER), which will support multidisciplinary research and education activities arising from advances in disciplinary research as well as crosscutting international activities. A crosswalk of the FY 2006 Current Plan is shown below.

GEO Reorganization Crosswalk
FY 2006 Current Plan
(Dollars in Millions)

Current Structure	New Structure				Total, Current Structure
	ATM	EAR	ICER	OCE	
Atmospheric Sciences (ATM)	216.09	-	19.38	-	235.47
EarthSciences (EAR)	-	140.12	12.75	-	152.87
Ocean Sciences (OCE)	-	-	26.24	288.25	314.49
Total, New Structure	$216.09	$140.12	$58.37	$288.25	$702.83

ATMOSPHERIC SCIENCES 226,850,000

The FY 2007 Request for the Division of Atmospheric Sciences (ATM) is $226.85 million, an increase of $10.76 million, or 5.0 percent, over the FY 2006 Current Plan of $216.09 million.

Atmospheric Sciences Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Atmospheric Sciences Research Support	135.68	133.85	141.12	7.27	5.4%
National Center for Atmospheric Research	79.64	82.24	85.73	3.49	4.2%
Atmospheric Sciences	**$215.32**	**$216.09**	**$226.85**	**$10.76**	**5.0%**
Major Components					
Research and Education Grants	96.45	95.55	106.41	10.86	11.4%
Centers Programs					
Center for Integrated Space Weather Modeling	4.00	3.96	4.00	0.04	1.0%
Center for Atmospheric Process Modeling	-	-	4.00	4.00	N/A
Facilities					
National Center for Atmospheric Research (NCAR)	79.64	82.24	85.73	3.49	4.2%
Research Resources and Infrastructure	35.23	34.34	30.71	-3.63	-10.6%

About ATM:

The extreme weather events of 2005 remind us that weather and climate affect every aspect of our daily lives. Tropical storms over the Atlantic Ocean, Caribbean Sea, or Gulf of Mexico can develop into fierce hurricanes that pound the East Coast, spawning tornadoes and producing torrential rains and floods, and resulting in large numbers of fatalities and billions of dollars in damage to property. In the upper reaches of the Earth's atmosphere, huge solar storms can damage satellites, disrupt communication and navigation systems, and cause widespread failures in the electrical power grid. The human impacts of urban pollution and extreme weather can be severe and costly. In order to improve our ability to predict and mitigate these events, we need to further our understanding of the physics, chemistry, and dynamics of the Earth's atmosphere, from the Earth's surface to the sun, on timescales ranging from minutes to millennia. We need to better understand the underlying trends, the impact of man-made changes, the complex interactions between systems, and the coupling among the atmosphere, the biosphere, and the oceans. The Division of Atmospheric Sciences supports such research through the provision of large, complex facilities, community modeling projects, cyberinfrastructure, and individual research grants, providing about 60 percent of the total federal support for academic atmospheric research.

ATM provides support for: 1) basic science projects and 2) the acquisition, maintenance, and operation of observational and cyberinfrastructure facilities and services that enable modern day atmospheric science research activities.

For the science activities supported by ATM, a variety of modes of support are used. Although the majority of this support is through the traditional "individual investigator" merit-reviewed, multi-year grants, ATM also supports: small scale, limited-duration exploratory research projects; collaborative or multi-investigator group projects focusing on a particular project, subject, or activity; large center or center-like projects; and funding for the research conducted by NSF's National Center for Atmospheric Research (NCAR) which extends and enhances research at universities.

Facility funding is provided through cooperative agreements to NCAR and several other institutions to acquire, maintain, and operate specific observational and cyberinfrastructure facilities that support the research and educational activities of NSF-sponsored projects, scientists, and students.

Facilities are approximately 45 percent of the ATM portfolio. Of the remaining funds, approximately 45 percent of funds support new awards and 55 percent are committed to funding awards made in previous years.

ATM priorities for FY 2007:

- Natural Hazards: Building on years of research to understand and predict weather and space weather phenomena, these research activities will be augmented to better understand and predict extreme events such as cyclone formation and life cycle;
- Biogeochemical Cycles: including emphasis on understanding the sources, sinks, and processes which control the atmospheric abundance and distribution of carbon, water, and other environmentally important elements;
- Environmental Modeling: Support for new data assimilation and innovative mathematical and statistical techniques to improve predictions of fundamental space, atmospheric, and Earth system processes;
- Cyberinfrastructure and Numerical Models: Improvements which will allow new discoveries, greater access to atmospheric data, and improved understanding of the atmospheric environment; and
- Interagency and International Programs: Continued support of these programs, including the U.S. Weather Research Program, the National Space Weather Program and cooperative international science programs.

Changes from FY 2006:

- Research and education grants and centers increase by $14.90 million, to a total of $122.44 million, and include:
  - an increase of $4.04 million in research activities at Science and Technology Centers;
  - an increase of $3.0 million in research on natural hazards (i.e. severe weather and space weather);
  - an increase of $2.0 million for cyberinfrastructure investments; and
  - an increase of $5.86 million in other disciplinary programs.

- Facilities decrease by $4.14 million to a total of $104.41 million, and include:
  - a planned decrease of $8.0 million for construction costs of the Advanced Modular Incoherent Scatter Radar (AMISR); and
  - an increase of $3.86 million across several NCAR and other facility programs.

Additional information on major ATM-supported facilities is available in the Facilities chapter.

EARTH SCIENCES $152,300,000

The FY 2007 Request for the Division of Earth Sciences (EAR) is $152.30 million, an increase of $12.18 million, or 8.7 percent, over the FY 2006 Current Plan of $140.12 million.

Earth Sciences Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Earth Science Project Support	103.67	106.46	115.90	9.44	8.9%
Instrumentation and Facilities	33.28	33.66	36.40	2.74	8.1%
Earth Sciences	**$136.95**	**$140.12**	**$152.30**	**$12.18**	**8.7%**
Major Components:					
Research and Education Grants	87.17	87.51	93.38	5.87	6.7%
Centers Programs					
Sustainability of Semi-Arid Hydrology and Riparian Areas	3.32	3.29	3.32	0.03	0.9%
National Center for Earth-Surface Dynamics	3.37	3.33	3.36	0.03	0.9%
Facilities					
Incorporated Research Institutions for Seismology (IRIS)	11.90	12.00	12.90	0.90	7.5%
EarthScope Operations	4.69	6.72	11.61	4.89	72.8%
Other Earth Sciences Infrastructure	21.57	22.02	22.48	0.46	2.1%

About EAR:

The Earth functions as a complex system that affects every aspect of our daily lives. The clean water we require to sustain life is made available through the hydrologic cycle. Soil forming processes are absolutely essential to agriculture. Our energy is largely provided by fossil fuels discovered in the subsurface and pumped or mined. Earthquakes periodically result in devastating loss of property and lives and erupting volcanoes are fed by tectonic processes deep in the earth and may create great societal disruption. EAR supports the study of these and many other Earth processes by providing funds for research and education, instrumentation, cyberinfrastructure, and shared-use facilities.

EAR provides support for: 1) basic science projects and 2) the acquisition, maintenance, and operation of observational and cyberinfrastructure facilities and services that enable modern day Earth science research activities.

Earth science is moving into a new era as we deploy an unprecedented array of instrumentation to image the planet's interior, sense the tectonic motions of the surface (for example, with NSF's EarthScope project), and establish observatories for study of the Earth's environmental systems. One way of addressing the Earth's complexity is through geoinformatics, the collaboration between geoscientists and computer scientists to solve complex scientific questions. EAR has enhanced its support to link available data sets, standardize documentation, and provide easy-to-use access tools and computer modeling and analysis codes for scientists and educators alike. EAR supports geoinformatics research and activities devoted to analyzing, modeling, and developing interactive capabilities for extensive and diverse data sets. Projects currently supported include:

- Consortia of universities, such as the Incorporated Research Institutes for Seismology (IRIS), UNAVCO, Inc., and WInSAR maintain highly sophisticated seismic, geodetic, and satellite radar data that are heavily used by the research and hazards community. For example, the seismic data provided by the IRIS system gave emergency personnel the first indication of the location and severe damage potential of the Great Sumatra earthquake and tsunami of December 2004.

- The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) is developing a hydrologic information system that will provide seamless access to a variety of datasets such as the National Water Information System, the Ameriflux tower network and the National Climatic Data Center. These systems are increasingly vital for decisions affecting water management in arid regions, flood mitigation, and groundwater pollution containment.
- In the developmental stages are projects linking data sets bearing on sedimentary sequences and geologic time. This will greatly improve our understanding of the Earth's surface environments.
- The Southern California Earthquake Center (SCEC) has been utilizing computational facilities at the University of California San Diego Supercomputer Center to build complex models of the crust of southern California. Their results are providing significant input to disaster preparedness and a better understanding of fundamental earthquake processes.
- The Geoscience Network (GEON) consortium is a collaboration of computer scientists and geoscientists working on a variety of fronts to create cyberinfrastructure of applicability to earth scientists. They are also working on a system that allow the user to create synthetic seismograms using the Terragrid, on services for processing LiDAR imagery, on three- and four-dimensional visualization and on educating the next generation of cyber-Earth scientists.
- The Computational Infrastructure for Geodynamics (CIG) project, headquartered at the California Institute of Technology, but with participation of at least 24 other research institutions, will focus on developing advanced software to enable individual Earth scientists to produce more realistic simulations in fields such as seismology, plate tectonics, volcanism, and geomagnetism.

EAR priorities for FY 2007:

- EarthScope Operations and Science Support: The new EarthScope facility, being constructed through the MREFC account, is continuing to ramp up operations and enabling new science at the intersection of several subfields within the earth sciences. Supporting the operation of the facility and the science it enables continues to be a high priority for EAR. Additional information can be found in the MREFC chapter.
- Maintaining a strong, flexible program of research and education grants to create new ideas and technologies and attract and train students is the primary focus in stewardship of the EAR portfolio. Emphasis will be given to increasing the support for theoretical research, including the biological geosciences, the hydrologic sciences and the study of natural hazards, such as earthquakes and volcanic eruptions. The key element across the EAR portfolio is expanding the science community's capability for computationally challenging global-scale research, such as dynamic modeling of Earth system processes, and managing and integrating very large data sets.

Changes from FY 2006:

- Research and education grants increase $9.44 million, to a total of $115.90 million. EAR will continue to support forefront areas of the Earth sciences, with continued emphasis on EarthScope science and operations, geohydrology, cyberscience, and geobiology. Education and outreach activities receiving continued emphasis include: enhancing science teacher training, expanding diversity within the research community, and integrating research and education.
- Facilities increase by $2.74 million to a total of $36.40 million. The increase is primarily for support of shared research facilities with a focus on geoinformatics.

INNOVATIVE & COLLABORATIVE EDUCATION AND RESEARCH $58,570,000

The FY 2007 Request for the Division of Innovative & Collaborative Education and Research (ICER) is $58.57 million, an increase of $200,000, or 0.3 percent, over the FY 2006 Current Plan of $58.37 million.

Innovative and Collaborative Education and Research Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Innovative & Collaborative Education and Research	**$54.11**	**$58.37**	**$58.57**	**$0.20**	**0.3%**
Major Components:					
Research and Education Grants	48.87	53.17	53.17	-	-
International Collaborations	5.24	5.20	5.40	0.20	3.8%

About ICER:

The Innovative and Collaborative Education and Research subactivity supports novel, complex, or partnership projects in both research and education. These investments cut across traditional boundaries within the geosciences, encouraging interdisciplinary activities and responding directly to critical needs of the entire geoscience community. ICER's principal goals are to develop innovative means to initiate and support geoscience education, attract underrepresented groups to careers in the geosciences, foster the interchange of scientific information nationally and internationally, and to join with other parts of NSF in major integrative research and education efforts.

In general, awards in targeted education programs and international projects are managed in ICER and awards associated with NSF-wide efforts are managed in the GEO divisions. Approximately 70 percent of funds are available for new awards each year and the remaining 30 percent are committed to awards made in previous years.

ICER Priorities for FY 2007:

Education and Broadening Participation in the Geosciences: Cross-divisional education activities include investments in development of curricula and resources specific to broad geoscience education, a leadership activity for geoscience teachers, and support for internet capabilities for geoscience education. In FY 2007, resources will be targeted at increasing the diversity of the geoscience workforce and enhancing the linkages between exisiting education and diversity projects and LSAMP awards. In a partnership with NASA, NSF will continue support for the GLOBE program. GEO contributes to programs for interdisciplinary graduate education (IGERT) and outreach to students (GK-12).

Interdisciplinary Research: ICER supports a major competition on Carbon and Water in Earth Systems. This research is within the NSF-wide framework for Biocomplexity in the Environment and aims to increase fundamental understanding of the interrelation of physical, chemical, geological, hydrologic, atmospheric, and biological processes that comprise the Earth's natural systems. In addition, ICER provides support to the NSF-wide investments in Mathematical Sciences, especially regarding modeling of complex systems; and Human and Social Dynamics, particularly regarding decision making and uncertainty.

Ecology of Infectious Diseases. Jointly with the Biological Sciences activity and the National Institutes of Health, ICER continues to support NSF's Ecology of Infectious Diseases program, which directly contributes to homeland security. The focus of the program is to explore the processes that govern relationships between human-induced environmental changes and the emergence and transmission of infectious diseases.

International Collaborations. ICER will continue support of targeted, catalytic international partnerships related to the broad interests of the geosciences, especially those that encourage global and regional scientific observations and information-sharing, and enable participation by U.S. investigators. One example is the Inter-American Institute for Global Change Research, a program that fosters research across the Americas.

Changes from FY 2006:

Funds for awards to international groups that support, plan, and coordinate a variety of geosciences activities around the world increase by $200,000, to a total of $1.50 million.

OCEAN SCIENCES $307,130,000

The FY 2007 Request for the Division of Ocean Sciences (OCE) is $307.13 million, an increase of $18.88 million, or 6.5 percent over the FY 2006 Current Plan of $288.25 million.

Ocean Sciences Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Ocean Section	99.72	107.58	114.62	7.04	6.5%
Integrative Programs Section	112.48	105.46	112.37	6.91	6.6%
Marine Geosciences Section	78.59	75.21	80.14	4.93	6.6%
Ocean Sciences	**$290.79**	**$288.25**	**$307.13**	**$18.88**	**6.5%**
Major Components:					
Research and Education Grants	144.97	139.57	141.85	2.28	1.6%
Long-term Ecological Research Centers	3.63	3.00	3.50	0.50	16.7%
Centers Program					
Center for Coastal Margin Observation/Prediction	-	-	4.00	4.00	N/A
Facilities					
Academic Research Fleet	70.97	73.00	77.50	4.50	6.2%
Integrated Ocean Drilling Program (IODP)	37.20	29.00	25.80	-3.20	-11.0%
Other Ocean Sciences Infrastructure	29.72	32.17	42.97	10.80	33.6%

About OCE:

The oceans play a pivotal role in climate, with the largest and most unexplored habitat for life on Earth and providing routes for commerce and sites for recreation. The oceans are also the source of important food and energy resources, and enormous reservoirs of heat and energy that spawn hurricanes and other cyclonic storms, sometimes with disastrous impacts on coastal and inland communities. Ocean scientists, through research supported by OCE, have made major advances in the understanding of ocean biology, chemistry, geology, and physics. Research and education supported by OCE 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 and infrastructure required to gain access to the ocean, including research vessels, manned and unmanned deep diving submersibles, and a wide range of technologically advanced sensors and 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.

The OCE portfolio has three highly integrative programmatic areas of support: research grants, education grants, and facilities to serve research and education activities.

- OCE research grants range from awards to individual scientists, to small groups of collaborating scientists, to several large coordinated projects involving international partners and user facilities.
- OCE education grants support graduate students and undergraduate research experiences, K-12 educational activities, and informal education for the general public. The Centers for Ocean Science Education Excellence (COSEE) form a major education and outreach network that facilitates the dissemination of ocean-centered educational material and information.

- OCE also supports acquisition, operation, and maintenance of major world-class facilities required to provide access to the oceans in order to address the highest priority science questions. Additional information on OCE-supported facilities is available in the Facilities chapter of this document.

Facilities are approximately 43 percent of the OCE portfolio. Of the remaining 57 percent, approximately 65 percent of funds support new awards and 35 percent are for awards made in previous years.

OCE Priorities for FY 2007:

Maintaining a strong, flexible program of research and education grants and facilities support to create new ideas and technology and attract and train students, is the highest priority in this portfolio.

- The Ocean Observatories Initiative (OOI) will address the growing need for sustained time-series observations. As our knowledge of the oceans has improved, the realization has grown that few characteristics of the ocean are in steady state – the ocean and the seafloor beneath are highly dynamic environments. If these processes are to be understood, if new insights are to be gained, if quantitative models are to be validated satisfactorily, then observations are needed over time scales appropriate to the dynamics of these processes.
- The Integrated Ocean Drilling Program (IODP) is an international partnership of scientists, research institutions, and agencies exploring the evolution and structure of Earth as recorded in the ocean basins utilizing ocean drilling.
- Natural Hazards: Hurricanes, earthquakes, and tsunamis can be better predicted with greater understanding of the mechanisms causing such events.
- A NSF Science and Technology Center (STC) for Coastal Margin Observation and Prediction will study coastal margins using integrated observation and prediction technologies. The STC will advance understanding of coastal margins by creating the scientific infrastructure necessary to obtain reliable quantitative descriptions and analyses of integrated physical, chemical, and biological variables in estuaries, freshwater plumes, and continental shelves.
- Non-Equilibrium Ecosystem Dynamics: Many oceanic processes are inherently nonlinear, so that small perturbations at one frequency can cause large-scale changes at another. The propagation of non-native species, the proliferation of harmful algal blooms, and the effectiveness of marine reserves are all examples where sophisticated ecosystem knowledge is required.
- The network of Centers for Ocean Science Excellence (COSEE) and other ocean education programs integrate ocean-science research in delivering high-quality education programs, and promote a deeper public understanding of the oceans and their influence on quality of life and national prosperity. COSEE partnerships foster interactions among research institutions, formal education organizations and informal education providers like museums.
- Providing scientists with access to the sea via modern infrastructure is essential for advancing our knowledge of the oceans. Building upon recommendations of the National Academy of Sciences and the Federal Oceanographic Facility Committee (FOFC), several projects will continue, including the construction of three regional-class research vessels to replace aging and less capable ships.

Changes from FY 2006:

- Research and education grants increase by $2.28 million, to a total of $158.80 million. OCE will continue to support forefront areas of ocean science, with expanded emphasis on complex systems and the temporal exploration of the oceans. Education and outreach activities will receive continued emphasis: enhancing COSEE, expanding diversity within the research community, and integrating research and education, including the training of young ocean scientists.
- Support for facilities increases $9.89 million, to a total of $144.0 million.

MATHEMATICAL AND PHYSICAL SCIENCES $1,150,300,000

The FY 2007 Budget Request for the Mathematical and Physical Sciences (MPS) Directorate is $1.15 billion, an increase of $64.85 million, or 6.0 percent, over the FY 2006 Current Plan of $1.09 billion.

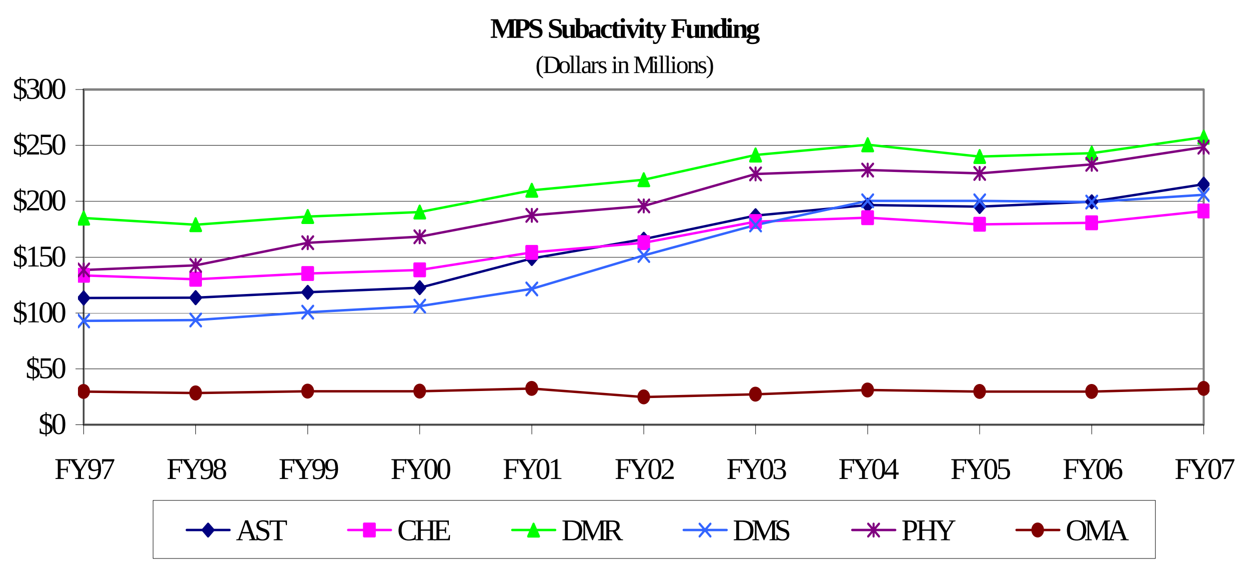
Mathematical and Physical Sciences Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Astronomical Sciences (AST)	$195.11	$199.65	$215.11	$15.46	7.7%
Chemistry (CHE)	179.26	180.78	191.10	10.32	5.7%
Materials Research (DMR)	240.09	242.91	257.45	14.54	6.0%
Mathematical Sciences (DMS)	200.24	199.30	205.74	6.44	3.2%
Physics (PHY)	224.86	233.13	248.50	15.37	6.6%
Multidisciplinary Activities (OMA)	29.80	29.68	32.40	2.72	9.2%
Total, MPS	$1,069.36	$1,085.45	$1,150.30	$64.85	6.0%

Totals may not add due to rounding.

The Mathematical and Physical Sciences Directorate (MPS) provides funds for research, infrastructure, and development of human resources in the mathematical and physical sciences. The portfolio of investments contains a mixture of research and education grants (including awards for groups, centers, and institutes), facilities (including the national astronomy centers), instrumentation, and awards that enhance opportunities for undergraduate and graduate students and postdoctoral researchers and broaden participation in MPS fields. It includes MPS participation in NSF-wide and interagency research and education, and emphasizes discovery, innovation, and learning aligned with NSF and national priorities.

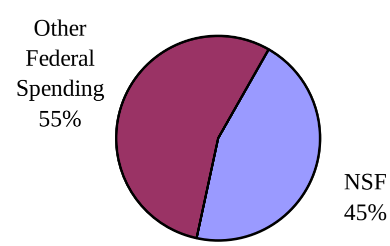


RELEVANCE

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, MPS-supported research advances the frontiers of knowledge, drives technological developments, and stirs the imagination. It spans the spatial scales from quarks to the cosmos and time scales from the incredibly short to the unimaginably long, and it brings the perspective and methodologies of the physical sciences to exploring the molecular basis of life processes, human and social dynamics, and sustainability of energy and environment. Increasingly, MPS research draws on sophisticated and mathematically precise computer models, application-specific software to implement the models, and capabilities for manipulating and extracting information from large, complex data sets.

MPS-supported research in the physical and mathematical sciences provides the backbone for advances in other technical, engineering, and health-related disciplines, and provides a broad basis for industrial and technological development and national security. Knowledge of the fundamental processes of matter, of the structure and evolution of the universe, of the complex laws governing chemical interactions, of the behavior and control of molecules at the nanoscale, and of the mathematical tools needed to formulate and solve such problems have played a fundamental role in the technological leadership of the United States and in maintaining its health, economy, defense, and homeland security. At the same time this research sparks the innovation that is crucial to maintaining U. S. competitiveness and generating new industries. In addition, by linking research with education and training, MPS promotes development of the future U.S. science, engineering, and technological workforce, with particular emphasis on broadening participation to engage the Nation's entire talent pool.

Federal Support of Basic Research in Math and Physical Sciences at Academic Institutions



MPS provides about 45 percent of federal funding for basic research at academic institutions in the mathematical and physical sciences and serves as the federal steward for ground-based astronomy. MPS provides about 40 percent of the federal support for academic astronomy; in chemistry, about 38 percent; in physics, approximately 32 percent; in materials research approximately 55 percent; and in mathematics more than 77 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.

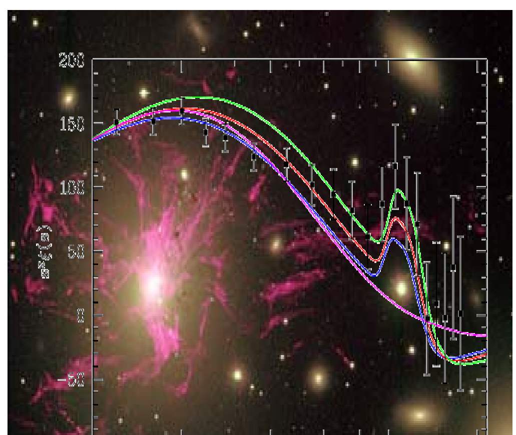
The MPS investment portfolio is designed to enable strong, flexible disciplines that generate discoveries across the MPS frontiers, reach out to other disciplines, accept high-risk undertakings that promise significant advances on fundamental questions, and drive innovation. The portfolio provides broad support across all MPS fields and catalytic support that promotes advances in areas of opportunity, including investments in the infrastructure supporting the conduct of MPS research and education and enabling broad access to it. In FY 2007, the MPS portfolio will include an expanded investment in elementary particle physics to capture a unique opportunity (see next page), as well as an expanded investment in nanoscale science and engineering. MPS infrastructure investments range from tabletop instruments to international facilities with hundreds of users as well as the development of next-generation instrumentation.

MPS integrates these investments in research and infrastructure with investments aiming 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.

The strength of the U.S. technical and instructional workforce is dependent on an adequate supply of talented scientists and teachers. To ensure a diverse, internationally competitive and globally-engaged workforce of scientists, engineers and well-prepared citizens, MPS will make investments in all phases of education – from K-12 through undergraduate, graduate, postgraduate, and continuing education, as well as outreach activities. In order to attract the large, diverse population found in today's undergraduate student body to careers in science and engineering, MPS is emphasizing activities connecting undergraduate education with research. MPS will also support partnerships aimed at enhanced teacher preparation, broadened graduate and postdoctoral opportunities, and more informed teaching and learning strategies. In all these activities, the MPS strategy relies on using the excitement of research on the frontiers to attract the next generation of scientists and engineers.

Elementary Particle Physics Investment. The opportunities for discovery in elementary particle physics (EPP) are greater than at any time in the last half-century. Recent discoveries strongly suggest that we are on the verge of a revolution in our understanding of the nature of matter, energy, space, and time, as well as the origin, evolution and destiny of the Universe. The questions that define EPP now involve the related fields of nuclear physics, astrophysics and cosmology, and the tools needed for breakthrough discoveries now include telescopes, ultra-sensitive detectors housed in underground laboratories, and beams of particles from reactors and the cosmos, as well as accelerators. These developments have made the field more interdisciplinary, exciting and vital, prompting a coordinated investment of $15 million, provided over FY 2006 and FY 2007, for university-based EPP research.

Cosmic Sound and Dark Energy: NSF-supported researchers have provided strong new evidence that the universe took on its present shape because the cosmic equivalent of sound waves rolled through its contents for about a million years after the Big Bang some 13.7 billion years ago.



Credit: Graph: Daniel Eisenstein, University of Arizona. Background Image: NOAO/AURA/NSF.

Using data from the Sloan Digital Sky Survey, which is funded in part by NSF, astronomers searched for clues in the distances between hundreds of thousands of galaxies. What they found is exactly the kind of distribution that would appear if the early cosmos were permeated by alternating waves of compression and rarefaction that moved much as a resonant musical note travels through air. Daniel Eisenstein of the University of Arizona, along with colleagues there and elsewhere, made the discovery of a small but clear "bump" in an otherwise smooth curve depicting the separation between galaxies. (See illustration.) The celebrated finding confirms and refines scientists' current view of the universe in which expansion is accelerating, and 95 percent of the contents are in the form of exotic "dark matter" and "dark energy."

Summary of Major Changes by Division	*(Dollars in Millions)*
MPS FY 2006 Current Plan……………………………………………………………...	**$1,085.45**
Astronomical Sciences Division (AST) Increased funding for research grants and instrumentation, with emphasis on areas relevant to the interagency Physics of the Universe (POU) activity in partnership with the Physics Division, DOE and NASA; cyberscience and cyberinfrastructure, including implementation of a national virtual observatory; Gemini Observatory operations and instrumentation; and strategic public-private partnerships, including design and development for the Giant Segmented Mirror Telescope.	+$15.46
Chemistry Division (CHE) Increased funding for a strong, flexible grants program that advances the frontiers of chemical sciences, emphasizing areas such as the molecular basis of life processes, sustainability in energy and environment, nanoscale science and technology, and improved sensors for homeland security; developing cyber-enabled chemistry; and broadening participation through investments in undergraduate participation in research.	+$10.32
Division of Materials Research (DMR) Increased funding for materials research programs that generate new ideas and novel materials and undergird innovative technologies, with emphasis on materials and phenomena at the nanoscale, biologically related materials, computational materials research and materials theory, and materials for future cyberinfrastructure; broadening participation in materials research; and maintaining support for world-class user facilities while enabling the development of future instrumentation.	+$14.54
Division of Mathematical Sciences (DMS) Increased funding for the fundamental mathematics component of the Mathematical Sciences Priority Area (MSPA), while initiating the mainstreaming of MSPA activities; algorithm development and computational tools for large-scale problems of scientific importance; enhanced opportunities for undergraduate participation in cross-disciplinary research involving mathematics; and broadening participation.	+$6.44
Physics Division (PHY) Increased funding to advance the frontiers of physics, with emphasis on elementary particle physics, the interagency Physics of the Universe activities with the Division of Astronomical Sciences, DOE, and NASA; research and education grants to create new ideas and technologies and attract and train students; and provide levels of support for user facilities that enable them to reach their potential. Phase out of the terminated RSVP project is complete.	+$15.37
Office of Multidisciplinary Activities (OMA) Increased funding for collaborative activities aimed at initiating innovative cross-disciplinary research, as well as broadening participation in and informing the public about MPS disciplines.	+$2.72
Subtotal, Changes	+$64.85
FY 2007 Request, MPS………………………………………………………………………	**$1,150.30**

Summary of Major Changes by Directorate-wide Investments *(Dollars in Millions)*

MPS FY 2006 Current Plan……………………………………………………………………..$1,085.45

Advancing the Frontier +$31.24

MPS places high priority on its investments in fundamental research aimed at advancing the frontiers of knowledge, including support for the research of individual investigators, groups, and larger collaborative activities, including institutes. In approaching its investments in core research in support of the NSF strategic goals, MPS looks for opportunities that excite the imagination, connect with areas of national priority as articulated in Administration guidance, and create synergy. MPS recognizes the importance of maintaining a significant component of activity that, while viewed as high risk, has high potential payoff. MPS staff aim for balance in award size and duration and success rate across the fundamental research portfolio. Emphases include:

- *Elementary Particle Physics (EPP)*, a coordinated investment of $10.0 million ($5.0 million in FY 2006 and $5.0 million additional in FY 2007) in fundamental research across (1) the energy frontier – the attempt to discover new fundamental particles and laws of physics by studying collisions at the highest energies achievable with current and future accelerators (+$2.0 million); (2) the neutrino frontier – exploration of the properties of the neutrino, a particle now known to carry mass and believed to be fundamental to understanding the developing universe (+$5.0 million); and (3) the cosmic frontier – the study of dark matter and dark energy (+$3.0 million). Investments in the cosmic frontier intersect with emphases in the Physics of the Universe. (The remainder of the $15.0 million EPP investment is found under Facilities and Instrumentation.)
- *Physics of the universe (POU)*, a set of activities that builds on the National Science and Technology Council report of the same name and partners with DOE and NASA in an interagency effort to explore the mysteries of dark matter and dark energy; the earliest phases in development of the universe, the fundamental nature of time, matter and space; and the role of gravitation. Funding will increase by $8.50 million over FY 2006, with $2.50 million of these funds overlapping with the EPP investment.
- *Fundamental mathematical and statistical science*, activities that strengthen the core of the Mathematical Sciences Priority Area and enable effective partnering with all other parts of NSF as well as NIH and DARPA. Funding for this priority area remains constant in DMS and scales back in the other divisions in accordance with NSF-wide planning for mainstreaming the priority area's activities in ongoing programs. An additional $5.10 million is provided for related research activities in DMS.
- *Physical sciences at the nanoscale*, activities that provide the foundation for innovative nanoscale technologies. These activities are undertaken in partnership with other NSF organizations and the government-wide National Nanotechnology Initiative and include efforts to address societal impacts of nanotechnology and the need for an educated workforce and an informed public. The activities emphasize the use of interdisciplinary teams conducting forefront research. Funding increases by $14.88 million, with DMR taking the lead in this activity for MPS.
- *Cyberinfrastructure and the cyberscience it enables*, connecting with NSF's high priority activities in this area and related activities government-wide in Networking and Information Technology R&D. MPS funding for domain-specific cyberinfrastructure increases by $4.26 million to a total of $63.56 million in a mix of core and infrastructure investments.
- *Molecular basis of life processes*, a set of activities linked to Administration priorities aimed at understanding complex biological systems. It will enable explorations in areas such as how disordered collections of molecules assemble themselves into the elements of living

systems; how proteins fold and membranes work; and how physiological processes such as breathing and thinking emerge out of complex, coupled arrays of individual reactions. CHE leads this effort, with DMR, PHY, and OMA as active participants. The increase is $9.35 million in a mix of individual, group and center research activities and infrastructure development.

- *Sustainability,* a newly focused investment in areas that link the physical sciences with environmental sustainability, including green chemistry, water chemistry and energy, with an increment of $2.0 million to leverage existing activities.

Facilities and Instrumentation +$17.32

Within an overall increase of $17.32 million for facilities and instrumentation, MPS targets the additional funds on increasing support for new and emerging facilities and for instrumentation development, including design and development for future facilities, cyberinfrastructure, and mid-scale projects, generally maintaining the base of funding for established facilities at FY 2006 levels.

- *Current facilities.* Funding for the Large Hadron Collider increases by $4.64 million; for LIGO by $1.32 million. The Cornell Electron Storage Ring (CESR) receives $5.0 million in funding from the focused EPP investment for a total of $14.71 million, slightly above the FY 2006 level. This funding will enable enhanced accelerator research and development, redirection of particle physics efforts towards the energy frontier, and completion of CESR's approved collider program over a somewhat longer period than originally planned. The extended time frame for CESR will also allow its partner facility, the Cornell High Energy Synchrotron Source (CHESS; included in Other MPS Facilities) to maintain cost-effective operations during this period. Base funding for astronomy facilities is at the FY 2006 level. Funding for the Gemini Observatory increases by $1.74 million for second generation instrumentation. Other facilities receive modest increases to support maintenance and operations at effective levels. (See the facilities table below for additional detail.)
- *Design and development.* Priority was accorded to design and development activities for potential future facilities, including $5.0 million for the Giant Segmented Mirror Telescope. Funding for the Large Synoptic Survey Telescope and the Energy Recovery Linac is maintained at planned levels.
- *Construction of facilities.* In addition, there are two MPS-related projects in construction phases with funding requested in FY 2007 from the MREFC account: the Atacama Large Millimeter Array (ALMA) and IceCube. Early operations funding for ALMA increases by $2.0 million. The termination of the Rare Symmetry Violating Processes (RSVP) project, also proposed for the MREFC account, is now complete. For more information, see the MREFC chapter.
- *Cyberinfrastructure.* The portfolio of world-class facilities that MPS maintains for the science and education communities represents a capital investment of well over $1.0 billion. Remote access to these facilities and analysis of the data they generate are aided by increasingly sophisticated cyberinfrastructure.
- *Instrumentation.* In addition to supporting these state-of-the-art facilities, which are open to all on the basis of scientific merit, MPS activities include public-private partnerships for research and development on astronomical instruments; development of new instrumentation in chemistry; enhanced user support and instrumentation for research at materials research facilities; expanded efforts in accelerator physics and physics instrumentation for experiments in particle and nuclear astrophysics and research; and enhanced computational investments for mathematics.

MPS Facilities Funding
(Dollars in Millions)

Facilities	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Cornell Electron Storage Ring (CESR)	$16.62	$14.56	$14.71	$0.15	1.0%
GEMINI Observatory	15.48	18.26	20.00	1.74	9.5%
Large Hadron Collider (LHC)	10.51	13.36	18.00	4.64	34.7%
Laser Interferometer Gravitational Wave Observatory (LIGO)	32.00	31.68	33.00	1.32	4.2%
MSU Cyclotron	17.50	17.32	17.60	0.28	1.6%
Nanofabrication (NNUN/NNIN)	2.80	2.77	2.80	0.03	1.1%
National High Magnetic Field Laboratory (NHMFL)	25.50	25.74	26.50	0.76	3.0%
Rare Symmetry Violating Processes (RSVP)	2.65	0.99	-	-0.99	-100.0%
National Astronomy and Ionosphere Center (NAIC)	10.52	10.46	10.46	-	-
National Center for Atmospheric Research (NCAR)	1.04	1.12	1.12	-	-
National Optical Astronomy Observatories (NOAO) [1]	37.94	36.91	40.05	3.14	8.5%
National Radio Astronomy Observatory (NRAO)	47.03	50.74	50.74	-	-
Other MPS Facilities	13.49	12.31	12.47	0.16	1.3%
Total, MPS	**$233.08**	**$236.22**	**$247.45**	**$11.23**	**4.8%**

[1] The NOAO total includes funding for instrumentation programs that build public-private partnerships. In FY 2007, the Telescope System Instrumentation Program increases by $2.0 million and the Adaptive Optics Development Program increases by $1.14 million, while the operations base for NOAO remains constant.

Broadening Participation in the S&E Enterprise +$5.21

Funding will emphasize inclusion of the professional societies and departments associated with MPS disciplines in addressing the issues related to broadening participation of women and underrepresented minorities, as well as investments aimed at broadening the base of institutions receiving MPS funds. Activities will emphasize partnerships, including linkages to facilitate the involvement of MPS communities in key NSF-wide programs such as LSAMP, AGEP, HBCU-UP, and CREST, and will use research experiences as the core of a strategy of partnering for diversity to attract members of underrepresented groups to MPS fields. OMA serves as a focal point for enhancing these investments.

Education and Workforce +$3.23

MPS will provide increases in support for CAREER, IGERT, Research Experiences for Undergraduates (REU) Sites, and Research Experiences for Teachers (RET). Enhancing the Mathematical Sciences Workforce for the 21st Century (EMSW21) increases by $500,000. Interdisciplinary undergraduate research experiences in computational sciences also increases by $500,000. MPS funding for Centers for Learning and Teaching decreases by $1.0 million with the planned termination of the higher education track. Investments in international opportunities for graduate students and internships in public science education will increase by $500,000.

Centers Programs +$7.85

MPS supports a number of activities that aggregate resources in support of disciplinary and interdisciplinary research that requires a greater level of effort in its conduct and meets NSF's center criteria. The Center for Layered Polymeric Systems at Case Western University was selected in the FY 2005 STC competition. In FY 2007, MPS will add $4.0 million to include this center, having transferred the funding from the Office of Integrative Activities budget line. The phase-out of three Materials Research Science and Engineering Centers is complete in FY 2006.

MPS Centers Funding
(Dollars in Millions)

Centers	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Chemistry Centers	$3.00	$1.48	$3.00	$1.52	102.7%
Materials Centers	$52.41	$53.66	$55.70	$2.04	3.8%
Nanoscale Science and Engineering Centers (NSEC)	13.00	12.83	12.96	0.13	1.0%
Science and Technology Centers (STC)	15.60	15.44	19.60	4.16	26.9%
Total, MPS	$84.01	$83.41	$91.26	$7.85	9.4%

Subtotal, Changes +$64.85

FY 2007 Request, MPS……..…………………………………..…………………………………. $1,150.30

NSF-wide Investments

In FY 2007, the MPS Directorate will support research and education efforts related to broad, Foundation-wide investments in a number of areas including NSF's multi-disciplinary priority areas and the Administration's interagency R&D priorities.

MPS NSF-wide Investments
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biocomplexity in the Environment	$3.83	$3.36	$1.00	-$2.36	-70.2%
Climate Change Science Program	5.45	5.45	5.45	-	-
Cyberinfrastructure	56.52	59.30	63.56	4.26	7.2%
Human and Social Dynamics	0.50	0.50	0.50	-	-
Mathematical Sciences	70.21	69.69	69.26	-0.43	-0.6%
National Nanotechnology Initiative	143.27	141.54	156.42	14.88	10.5%
Networking and Information Technology R&D	77.52	67.82	69.00	1.18	1.7%

Funding for the **Biocomplexity in the Environment** priority area will decrease in FY 2007 as part of the planned phasing down of the priority area. Funds will support activities related to environmental molecular science.

The MPS investment in the **Climate Change Science Program** is led by CHE through the U.S. Global Change Research Program. It is focused on sustainability, including green chemistry, water chemistry, and energy.

NSF's **Cyberinfrastructure** activities are related to NITRD investments. All MPS divisions emphasize ways in which cyberinfrastructure – high-end computing, networking, and data collection and management – can enable the science they conduct. The developing capabilities create new opportunities for collaboration in science. Modeling, simulation, and visualization are increasingly important tools for MPS fields, particularly for work that crosses scales of time and space. Investments in improving hardware, software, and data management capabilities enable researchers to ask new kinds of questions, which, in turn, stimulate the need for new, more powerful capabilities in cyberinfrastructure. In addition, MPS divisions contribute to research for the next generation of cyberinfrastructure through the development of software and algorithms and through research on next-generation materials for computation and computing.

Funding for **Human and Social Dynamics** includes support for areas such as interdisciplinary research modeling the development and evolution of social and organizational behavior in complex systems. Within MPS, the Division of Mathematical Sciences will support research on dynamic and agent-based models used in studying human and social dynamics.

As the **Mathematical Sciences** priority area is phased out, support within MPS will decrease slightly, but will continue targeting fundamental mathematical sciences, interdisciplinary mathematical sciences, and mathematical sciences education, with the balance among these areas reflecting the evolving nature of the interdisciplinary partnerships. 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.

MPS plays an important role, both within NSF and in the interagency working environment in the **National Nanotechnology Initiative**, investing a total of $156.42 million in FY 2007. Key areas for investment include fundamental nanoscale phenomena and processes and nanomaterials, with significant investments in instrumentation research, major research facilities, societal dimensions, and education. Many of the activities are carried out through interdisciplinary research teams. DMR is the lead division, with significant participation from CHE, PHY, and DMS.

All MPS divisions participate in funding for the **Networking and Information Technology R&D** (NITRD) program. The investment is focused in high-end computing infrastructure and applications, with contributions in high-end computing R&D and human-computer interaction and information management as well. GRID computing and the developing national virtual observatory are high-profile examples of MPS investments.

QUALITY

MPS 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 87 percent in FY 2005, 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 Mathematical and Physical Sciences Advisory Committee (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. Members represent a cross section of the mathematical and physical sciences with representatives from many different sub-disciplines within the field; and include members from institutions and industry. The Committee includes a balanced representation of women, members of underrepresented minorities and geographic regions. MPS also participates in three advisory committees that advise multiple agencies: the High Energy Physics Advisory Panel (with DOE); the Nuclear Science Advisory Committee (with DOE); and the Astronomy and Astrophysics Advisory Committee (with DOE and NASA). Standing committees and studies of the National Research Council provide another mechanism for obtaining advice.

PERFORMANCE

NSF's FY 2007 budget is also aligned to reflect funding levels associated with the Foundation's four strategic outcome goals and the ten investment categories highlighted in the FY 2003-2008 Strategic Plan. These categories were designed as a mechanism to better enable assessment of program performance and to facilitate budget and performance integration.

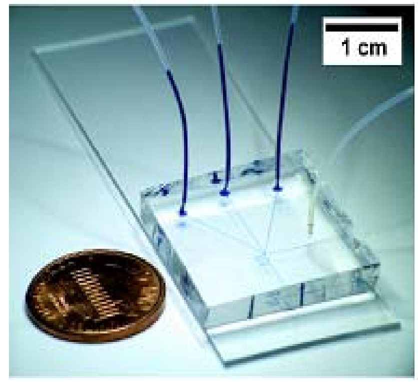
Mathematical and Physical Sciences
By Strategic Outcome Goal and Investment Category
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Ideas					
Fundamental Science and Engineering	$582.99	$606.87	$637.26	$30.39	5.0%
Centers Programs	84.01	83.41	91.26	7.85	9.4%
Capability Enhancement	-	-	-	-	N/A
	667.00	690.28	728.52	38.24	5.5%
Tools					
Facilities	136.55	136.99	145.08	8.09	5.9%
Infrastructure and Instrumentation	37.41	37.88	43.97	6.09	16.1%
Polar Tools, Facilities and Logistics	-	-	-	-	N/A
Federally-Funded R&D Centers	96.53	99.23	102.37	3.14	3.2%
	270.49	274.10	291.42	17.32	0.06
People					
Individuals	108.99	95.25	100.48	5.23	5.5%
Institutions	5.44	5.43	5.56	0.13	2.4%
Collaborations	10.32	13.86	17.19	3.33	24.0%
	124.75	114.54	123.23	8.69	7.6%
Organizational Excellence	7.12	6.53	7.13	0.60	9.2%
Total, MPS	$1,069.36	$1,085.45	$1,150.30	$64.85	6.0%

Totals may not add due to rounding.

Recent Research Highlights

► **Microfluid Technology on a Chip:** A group of NSF-supported researchers have invented a new way of testing biological reactions on a plastic chip – and then have used that technology to show that proper blood clotting depends critically on the precise arrangement of junctions between channels.

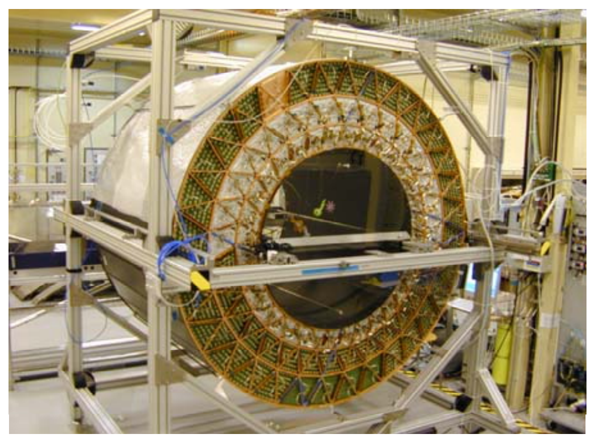


Credit: Helen Song, Rustem Ismagilov, University of Chicago.

Such reactions have been extremely difficult to study because it is hard to control conditions in an experiment. Now Rustem Ismagilov's lab at the University of Chicago is the first to recreate a chemical reaction network on a plastic chip, with micron-sized grooves many times thinner than a human hair. Chemical solutions flow through these grooves in a way that is controlled by the experimenter.

The team discovered that the proper function of clotting is dependent on the geometry of the junctions between the channels. This is a new principle in understanding the geometry of blood vessels and its role in proper clotting. The chip approach to reaction networks, now in its infancy, could make possible numerous new studies about reaction networks that result in emergent biological behavior. (CHE)

► **Detecting Progress:** Progress continues in NSF-funded work on the Large Hadron Collider (LHC), which is now under construction at the CERN laboratory in Geneva. Designed to be the world's most powerful particle accelerator, and scheduled to begin operations in 2007, the LHC will explore some of the deepest questions in science, including the nature of mass and why so many practically dimensionless subatomic particles have such a perplexingly wide array of masses. NSF is supporting the construction of two large detectors for this accelerator. Hampton University has been a partner in the development of one of these detectors (known as ATLAS). Hampton researchers have been heavily involved in the development of the complex particle tracking system known as the transition radiation tracker (TRT), and recently completed a number of sensitive tests successfully. (PHY)



The Transition Radiation Tracker (TRT) of the ATLAS detector. ATLAS, when completed, will be the largest particle detector ever constructed. *Credit: Hampton University.*

► **The Search for Other Worlds:** Using a relatively new planet-hunting technique that can spot worlds one-tenth the mass of our own, researchers have discovered a potentially rocky, icy body that may be the smallest planet yet found orbiting a star outside our solar system. Located more than 20,000 light years away in the constellation Sagittarius, close to the center of our Milky Way galaxy, the new planet is approximately five-and-a-half times the mass of Earth. Orbiting a star one-fifth the mass of the sun at a distance almost three times that of Earth's orbit, the newly discovered planet is frigid: the estimated surface temperature is -364 degrees Fahrenheit (-220 degrees Celsius). Although astronomers doubt this cold body could sustain organisms, researchers believe the new planet-hunting technique will bring opportunities for observing other rocky planets in the "habitable zones" of stars - regions where temperatures are perfect for maintaining liquid water and spawning life. (AST)

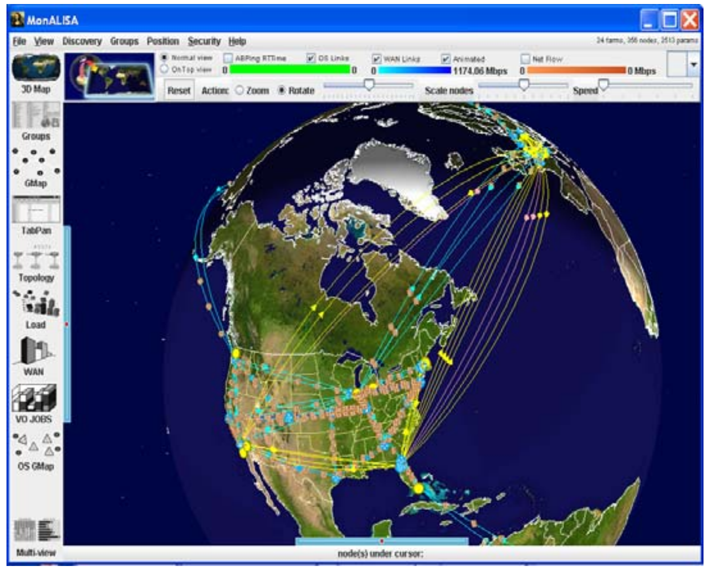
European Southern Observatory artist's rendition of the newly discovered extrasolar planet. *Credit: European Southern Observatory.*

► **The Search for Dark Matter:** Large-scale astronomical observations have shown that the universe is dominated by a haze of invisible “dark matter” having five times the total mass of normal matter. This dark matter remains unidentified because it cannot be detected directly by telescopes. However, its presence is inferred through the gravitational effects this matter exerts on visible matter. Theoretical calculations have led to the conclusion that the most likely candidate for dark matter is a massive particle called a WIMP (Weakly-Interacting Massive Particle).

This particle would rarely interact with normal matter. Nevertheless, it will interact on occasion and should be, in principle, detectable. The detection of WIMPS would provide a dramatic advance in our understanding of the material content of the universe and in our understanding of the nature of elementary particles. A team led by a Berkeley group has developed the world’s most sensitive detector for this purpose. It is the CDMS (Cold Dark Matter Search) detector, located underground in the Soudan mine in Minnesota. The detector consists of vertical arrays of hockey-puck sized germanium and silicon detectors, which sense the tiny signal resulting when WIMPS interact with the germanium and silicon nuclei. The CDMS detector is operated at temperatures that are just a few thousands of a degree higher than absolute zero. Recent results have set new limits on the interaction between WIMPS and ordinary matter. These results have already ruled out certain theoretical models but will help shape and constrain future theories. (AST, PHY)

Four of the Silicon and Germanium detectors in their mounts at the Soudan mine in Minnesota. *Credit: University of California, Berkeley.*

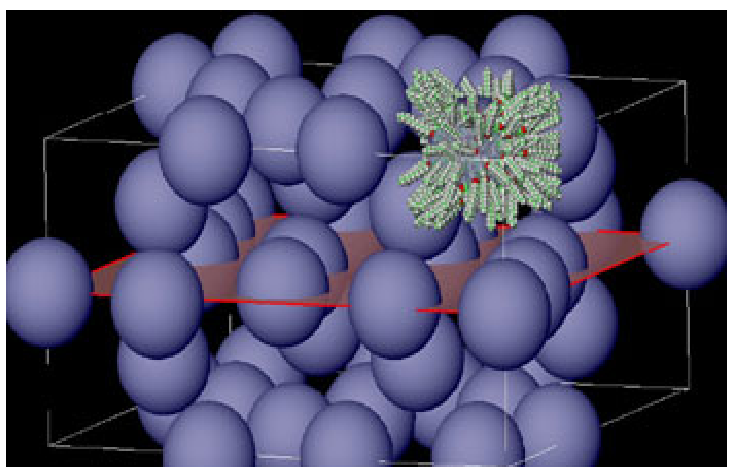
► **Global Collaboration Networks:** Within the next decade, scientists working at the outermost frontiers of high-energy physics and astronomy will be generating data in unprecedented volume – billions of gigabytes per year from just four NSF-funded projects alone. Since the processing and analyzing of that tsunami of information will demand far more computing power than any single facility can bring to bear, NSF is providing pioneering support for international computing networks, or "grids," that will do the job collaboratively. Examples include the nationwide Grid Physics Network (GriPhyN) to manage the data from two detectors at the Large Hadron Collider at CERN; the Laser Interferometer Gravitational Wave Observatory; and the Sloan Digital Sky Survey. Other programs, such as the International Virtual Data Grid Laboratory (iVDGL) and the UltraLight programs, have U.S., European, Asian and South American partners and will encompass more than 100 university- and laboratory-based grid sites that are collectively capable of meeting enormous data challenges. (PHY)



State-of-the art network, computing grid and software technologies are enabling global collaborations and discoveries in high energy physics and other data-intensive fields. *Credit: California Institute of Technology.*

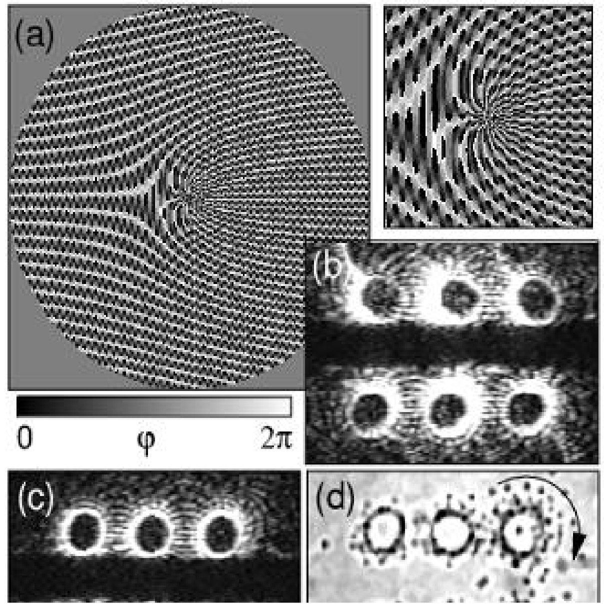
► **Molecular Self-Assembly:** NSF is enabling research into one of the most promising areas in science: the effort to understand – and to duplicate or even improve synthetically – the way that atoms and molecules in nature arrange themselves into various arrays with a host of specific functions. This kind of "bottom-up" programmed self-fabrication of materials is a key goal of nanoscience and may revolutionize manufacturing.

In one striking example of such research, scientists at the University of Pennsylvania created spherical branching molecules that assemble themselves into groups of precisely structured building blocks totaling about 250,000 atoms. The illustration shows two layers of these self-assembled nanostructures that form a complex lattice with a repetitive arrangement of 30 ball-like molecules, each represented as a blue sphere. (Each spherical molecule actually more closely resembles the tree-like shape shown in green and red at top right.) The spherical molecules form a liquid crystal material that may help build nanostructures for molecular electronics or photonics materials. Each repetitive unit of 30 spheres occupies a rectangular volume nearly 20 nanometers (billionths of a meter) by 10 nanometers. (DMR)



Credit: Virgil Percec, University of Pennsylvania.

► **Pumping with Light:** An NSF-supported research team has created one of the world's smallest fluid pumps – with no mechanical moving parts. As biomedical and chemical technology shrinks to ever smaller dimensions, there is an increasingly pressing need for active pumps and mixers that operate at length scales ranging from a few molecules to the size of microbes. David Grier's research team (recently moved to New York University from the University of Chicago) has developed a novel approach to that challenge that avoids all of the technological hurdles posed by micro- and nanofabrication by employing a recent breakthrough in creating computer-generated holograms with precisely directed beams of light.



Computer-designed "phase" hologram (a) transforms a laser beam into six optical vortices (b). The optimized array (c) drives particles in counter-rotating circles, thereby pumping surrounding fluid(d). *Credit: David Grier, New York University.*

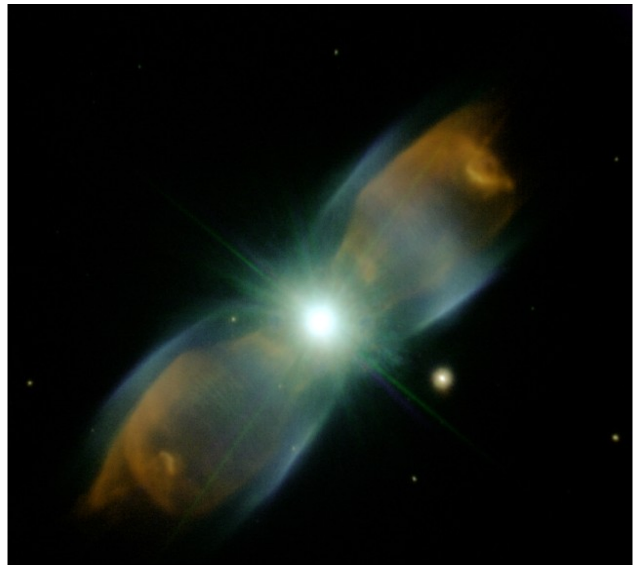
Holograms are produced when light rays are aimed so that they interact in specific ways to make up a multi-dimensional image. The NYU group harnesses the same fine control to make light beams act as "optical tweezers" to move objects on the scale of microns – millionths of a meter. (One micron is about 1/50th the width of a human hair.) The method works extremely well for investigating microscopic processes underlying everyday events such as melting and freezing, the lifecycle of cells and the emergent properties of materials. Although originally designed for fundamental research, the technique has applications that range from surgery within living cells, to manufacturing tiny sensors, to rapidly sorting fluid-borne objects with unparalleled selectivity. This technology has been commercialized and is being rapidly adopted for a wide range of industrial applications. (DMR)

► **Doctoring Computer Security:** The language of computer security is highly biological – systems are said to be "infected" by "viruses," "worms" and so on – and as a result, computer scientists often look to biological systems for inspiration. That's how Anil Somayaji, an NSF-supported Ph.D. student at the University of New Mexico, came to think about homeostasis: the physiological process by which the internal systems of the body are maintained within normal ranges despite variations in operating conditions. The body achieves homeostasis, for example, through its reactions to temperature variations, physical and psychological stresses, and microbial invaders. In the case of germs, containment and regulated coexistence are often the best strategies: drastic countermeasures are rarely called for.

How secure is your secure information? *Credit: William Rundell, National Science Foundation.*

With that in mind, Somayji and a colleague at the University of Minnesota began applying the notion of homeostasis to the "health" of computer systems under attack from security threats. Somayaji developed an extension for the Linux operating system, called pH, that maintains computer system stability by slowing the response to system calls when aberrant behavior is detected. That is, he modified the goal for computer security systems from rushing to destroy a perceived intruder when it is first recognized, to adapting the system to maintain stability. The ideas were commercialized and subsequently incorporated into a software program called Virus Throttle released by Hewlett-Packard Co. in February 2005. (DMS)

► Adaptive Optics and the Search for Planets: Researchers at the Gemini Observatory are developing next-generation instrumentation that will build on and expand the observatory's capabilities in adaptive optics: a technique that virtually eliminates the distortion in astronomical images produced by the atmosphere. The first application of such systems will be to search for planets around nearby stars. An example of the detail that can be obtained with the use of adaptive optics is the image shown here, taken with the ALTAIR adaptive optics system on the Gemini North 8-meter diameter telescope. A color composite image of the planetary nebula M2-9, it reveals remarkable details in the dynamic gas outflows from a dying star. The concentric shells of gas are still a mystery to astronomers and these data will help them to understand the complexities surrounding this beautiful object. (AST)



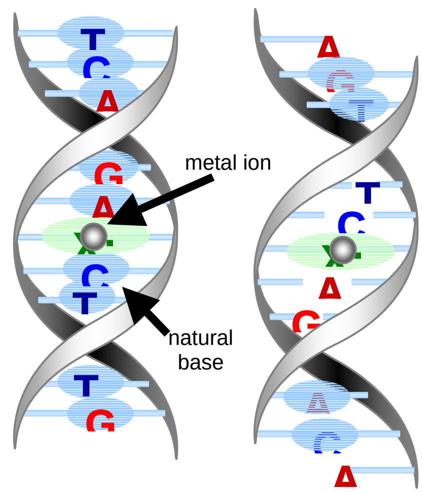
Credit: Gemini Observatories.

► Fireflies, Neurons, and the Wobbling of the Millennium Bridge: NSF-supported mathematicians have helped solve the strange case of the Millennium Bridge. This sleekly designed, pedestrian-only suspension bridge was the first new bridge constructed across London's Thames River in more than one hundred years, and its opening in June 2001 was eagerly awaited.

Credits: Steven H. Strogatz, Cornell University. Image of Millenium Bridge: http://en.wikipedia.org/wiki/London_Millenium_Bridge.

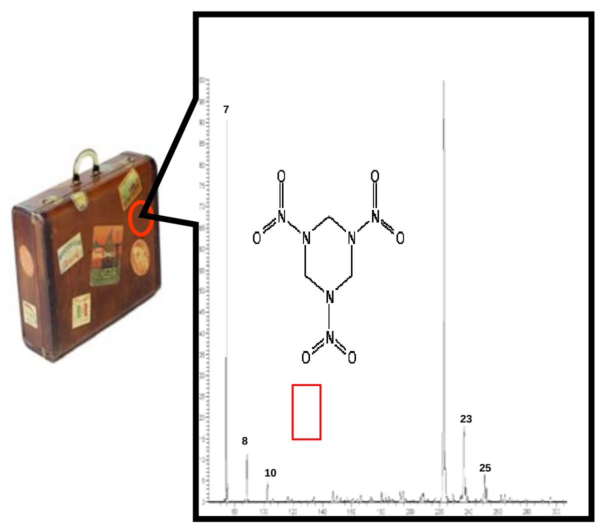
Disconcertingly, however, the large crowds that tried the bridge in its first weeks of service encountered swaying motions much larger than architects and engineers had anticipated – or could explain. Only recently has a convincing solution been advanced by Steven H. Strogatz (Cornell University), Edward Ott (University of Maryland) and their collaborators in the United Kingdom and Germany. Drawing on mathematical ideas originally used to describe the collective synchronization of independent biological oscillators such as fireflies and neurons, the researchers were able to explain how pedestrians were spontaneously falling into step with the bridge's small vibrations, and amplifying those vibrations well beyond what the standard engineering analyses had predicted. Their analysis even explained the curious fact that the Millennium Bridge was steady with 150 pedestrians on its deck, but swayed when the numbers rose above 160. Meanwhile, the bridge itself was closed for several months after the embarrassing opening, experiments were conducted, and dampers were installed between the bridge deck and the supporting piers to tame side-to-side motions. The refitted bridge is now a model of stability, and has become a well-used landmark. (DMS)

► **Electronic Circuits of the Future May Look A Lot Like DNA:** At Carnegie Mellon University, a research group lead by Catalina Achim has created a new class of DNA-like molecules that may eventually be used to store information, just as DNA itself does. The new molecules have a standard double-helix structure, with two strands winding around and around one another. But only one of their strands is formed from the standard DNA "backbone" of linked sugar molecules; the other is a protein-like chain of peptide molecules. Achim's group has shown that when metal ions are incorporated in the nucleic acids at specific locations, these artificial double helices, known as PNAs, can acquire a completely new set of magnetic and electrical properties. That result, in turn, opens new opportunities to create molecular-scale replicas of today's electronic circuit components, such as wires, diodes and transistors. (CHE)



Peptide and nucleic acid strands linked together by metal ions connecting the artificial bases. *Credit: Catalina Achim, Carnegie Mellon University.*

► **A Sensitive Nose for Explosives:** With funding from the National Science Foundation and the Office of Naval Research, the Graham Cooks research team at Purdue University has developed a powerful, new tool that simply and quickly analyzes surfaces for the presence of a common explosive. This tool, known as Desorption Electrospray Ionization Mass Spectrometry (DESI-MS), offers rapid, specific and sensitive detection of trace amounts of the explosive. In a demonstration, triacetone triperoxide (TATP) was detected on paper, brick, and metal surfaces. TATP is an easy-to-make, but hard-to-detect explosive that was used by terrorists for numerous suicide bombings, including the bombing of London subway trains in the summer of 2005. The detection of the explosive by DESI-MS is fast (less than 5 seconds) and no pretreatment of the surface is needed. In all of the cases studied so far, the tool has been highly selective and highly sensitive, detecting TATP at low nanogram limits. It provides a powerful, sensitive new tool for simply and rapidly analyzing surfaces for the presence of a common explosive. (CHE)



Rapid mass spectrometric detection of an explosive on an exposed surface. *Credit: Graham Cooks, Purdue University.*

► **Why So Few? Women in Physics from around the World Compare and Strategize:** How many women had the potential to be great physicists, but . . . ? Both nationally and internationally, women are seriously under-represented in physics and in other fields, such as engineering, for which physics knowledge is an essential prerequisite. The nature and magnitude of the problem varies from country to country, with some doing considerably better than the United States, and others doing considerably worse. However, there is remarkable consistency in one pattern: the percentage of women in physics in all countries decreases markedly with each step up the academic ladder, and with each level of promotion in industrial and government laboratories. Why is this true and what can be done? In May 2005, with NSF support for the U.S. delegation, 145 participants (93% women) from 42 countries met in Rio de Janeiro, Brazil, to discuss these issues, compare progress, and develop effective strategies. General discussion topics ranged from "Attracting Girls into Physics" to "Getting Women into the Physics Leadership Structure Nationally and Internationally" while individual presentations ranged from "Participation of Females in Physics Programs at the University of Botswana" to "Korean Physical Society's Physics Camp for High School Girls" to "Women in the Physical Sciences in Sweden: Do We Have True Gender Equality in a `Gender-Neutral' Country?" The Conference Proceedings are available. (PHY)

Credit: Hartline

► **The Adventure of the Apprentice's Stone:** The Pennsylvania State University Materials Research Science and Engineering Center for Nanoscale Science has collaborated with The Action Potential Science Experience to develop "*The Adventure of the Apprentice's Stone*": an innovative materials and nanoscience summer camp program designed to connect art, history, and science. The week-long journey transports students in grades 4 through 8 into the magical world of the Penn State School of Potions, where a series of hands-on explorations into the nanoworld will teach the young wizards that science is all around them. Activity topics include ferrofluids, nitinol, zeolites, and lithography. Each day's activities help students to unlock a secret message, which will eventually combine with other messages collected during the week to reveal the knowledge contained in the Apprentice's Stone. In the image an Apprentice Wizard is trapped on a straw model of a zeolite. (DMR)

An Apprentice Wizard is captured on a straw model of a zeolite. *Credit: Pennsylvania State University Materials Research Science and Engineering Center.*

Other Performance Indicators

Number of People Involved in MPS Activities

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Senior Researchers	6,373	6,400	6,500
Other Professionals	1,954	1,950	1,900
Postdoctorates	2,076	2,080	2,150
Graduate Students	7,042	7,100	7,200
Undergraduate Students	5,616	5,650	5,750
K-12 Students	250	275	320
K-12 Teachers	400	450	500
Total Number of People	23,711	23,905	24,320

MPS Funding Profile

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Statistics for Competitive Awards:			
Number	2,073	2,100	2,150
Funding Rate	29%	29%	30%
Statistics for Research Grants:			
Number of Research Grants	1,591	1,600	1,650
Funding Rate	27%	27%	28%
Median Annualized Award Size	$99,999	$100,000	$103,000
Average Annualized Award Size	$135,374	$135,000	$140,000
Average Award Duration, in years	3.1	3.1	3.1

ASTRONOMICAL SCIENCES $215,110,000

The FY 2007 Request for the Astronomical Sciences Division (AST) is $215.11 million, an increase of $15.46 million, or 7.7 percent, over the FY 2006 Current Plan of $199.65 million.

Astronomical Sciences Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Astronomical Sciences	**$195.11**	**$199.65**	**$215.11**	**$15.46**	**7.7%**
Major Components:					
Research and Education Grants	80.14	79.32	89.86	10.54	13.3%
Centers Programs	4.00	3.96	4.00	0.04	1.0%
Facilities	110.97	116.37	121.25	4.88	4.2%
Gemini Observatory	15.48	18.26	20.00	1.74	9.5%
National Astronomy and Ionosphere Center (NAIC)	10.52	10.46	10.46	-	-
National Optical Astronomy Observatory (NOAO) [1]	37.94	36.91	40.05	3.14	8.5%
National Radio Astronomy Observatory (NRAO)	47.03	50.74	50.74	-	-

Totals may not add due to rounding.
[1] Includes the National Solar Observatory.

About AST:

AST is the federal steward for ground-based astronomy in the U.S., working in partnership with private institutions to enhance overall observing capacity and capability. Research support covers a broad array of observational, theoretical, and laboratory research aimed at understanding the origins and characteristics of planets, the Sun, other stars, our galaxy, extragalactic objects, and the structure and origin of the Universe. Special grants and fellowship programs for young faculty, postdoctoral researchers, and undergraduate students encourage the activities of researchers engaged in education and outreach and increase the participation of underrepresented minorities in science. AST provides the U.S. share of funding for the operation of the international Gemini Observatory and supports the operation of four National Astronomy facilities: the National Astronomy and Ionosphere Center (NAIC), the National Optical Astronomy Observatory (NOAO), including the National Solar Observatory (NSO), and the National Radio Astronomy Observatory (NRAO). AST programs support the development of advanced technologies and instrumentation, planning and design for future observational facilities and major collaborative projects in astronomy, and management of the electromagnetic spectrum for scientific use.

The AST portfolio has two major modes of support: research and education grants and facilities.

- AST research and education grants range in scope from awards to individual-investigators to large collaborations carrying out extensive surveys or developing instrumentation.
- AST also supports major world-class facilities that provide access to a wide range of observational resources on a competitive basis. (Additional information about AST facilities is provided in the Facilities chapter of this document.)

Facilities are approximately 56 percent of the AST portfolio. In FY 2005, AST received 578 research proposals and made 155 competitive awards for a success rate of 27 percent.

AST Priorities for FY 2007:

Research Grants Programs are AST's highest priority in stewardship of the portfolio. Emphasis will be given to addressing scientific priorities articulated in the National Research Council's "Astronomy and Astrophysics for the New Millennium," supporting activities in the area of cyberinfrastructure/ cyberscience including a national virtual observatory in partnership with NASA, and ensuring a healthy and balanced program of research and education grants to the community.

Physics of the Universe (POU), the highest scientific priority, addresses the compelling questions that have arisen at the interface of physics and astronomy and were posed by the National Research Council (NRC) report, "Connecting Quarks with the Cosmos." A subsequent National Science and Technology Council report, "The Physics of the Universe: A 21st Century Frontier for Discovery," outlines a national investment plan involving NSF, DOE, and NASA. Within NSF, POU is coordinated and supported by the AST and PHY Divisions. Activities include funding within the grants program, instrumentation development, and new facilities.

Public-Private Partnerships are a keystone of the division's strategy. In FY 2007, there will be renewed investments in the **Telescope System Instrumentation Program** (TSIP) and the **Adaptive Optics Development Program** (AODP), as well as increased support for **Giant Segmented Mirror Telescope** (GSMT) technology development.

Gemini Observatory operations and instrumentation are AST's highest priority in facility stewardship. Ensuring the optimum performance and future instrumentation of our premier and newest optical/IR (infrared) facility enables forefront research by the scientific community and their students in this international partnership and strengthens the public-private partnerships.

Changes from FY 2006:

Research and education grants increase by $10.54 million to a total of $89.86 million. AST will continue to support a wide range of astrophysical investigations from the search for extrasolar planets to the origin of the universe. Development of tools for handling large data sets and implementation of the Virtual Astronomical Observatory in partnership with NASA are emphases in AST's approach to cyberinfrastructure/cyberscience. Education and outreach activities will receive continued emphasis. Support for technology development for the **Large-Aperture Synoptic Survey Telescope** (LSST) continues and that for GSMT will increase to $5.0 million.

Funding for the **Science and Technology Center for Adaptive Optics** is restored to $4.0 million.

Facilities increase by $4.88 million to a total of $121.25 million. Base operations funding for all facilities remains at the FY 2006 level, pending the results of the on-going Senior Review of AST facilities. See the Facilities chapter for details. Changes include:

- The increase of $1.74 million for the **Gemini Observatory** will enable enhanced operational and visitor support and continue the funding of a new generation of advanced instrumentation.
- The **NOAO/NSO** total includes design and development for the **Advanced Technology Solar Telescope** (ATST). NOAO support for TSIP increases by $2.0 million to $4.0 million, and support for AODP increases by $1.14 million to $1.50 million. Both are administered for the community through NOAO.
- **NRAO** is supported at the level of $50.74 million, as in the FY 2006 Current Plan. The total includes an increase of $2.0 million for ALMA early operations to a total of $6.0 million.

CHEMISTRY $191,100,000

The FY 2007 Request for the Chemistry Division (CHE) is $191.10 million, an increase of $10.32 million, or 5.7 percent, over the FY 2006 Current Plan of $180.78 million.

Chemistry Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Chemistry	**$179.26**	**$180.78**	**$191.10**	**$10.32**	**5.7%**
Major Components:					
Research and Education Grants	156.84	159.09	167.39	8.30	5.2%
Centers Programs	8.60	8.01	9.60	1.59	19.9%
Instrumentation/Facilities	13.82	13.68	14.11	0.43	3.1%

Totals may not add due to rounding.

About CHE:

The Chemistry Division (CHE) advances the intellectual frontiers of chemistry, which seeds innovation and competitiveness more broadly across society. CHE supports research that enables matter to be manipulated, measured, and modeled. Exquisite control in designing and synthesizing new molecules and molecular assemblies is the result. Understanding matter from this perspective is essential to advances in many allied fields, including the life, environmental, and materials sciences, as well as nanoscale science and engineering. CHE supports cyber-enabled chemistry, a new paradigm for chemical research and education. CHE invests substantially in the development of a diverse, internationally competitive workforce for the chemical sciences that can contribute to these advances.

Research supported by CHE covers a broad range of subfields, including organic and macromolecular chemistry; experimental physical chemistry; theoretical and computational chemistry; inorganic, bioinorganic and organometallic chemistry; and analytical and surface chemistry. Progress in these areas is vital to the health, wealth and security of the U.S. Strength in the chemical sciences is essential to fostering innovation that will maintain the U.S. as a leader and preferred partner in an increasingly global chemical enterprise. 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.

The CHE portfolio has three major modes of support: research and education grants, centers, and instrumentation and facilities.

- CHE research and education grants range in scope from individual investigator awards to multi-investigator awards that allow groups of researchers to collaborate on disciplinary and multidisciplinary projects.
- CHE Centers include six Chemical Bonding Centers (CBCs), a Science and Technology Center (STC) in environmentally responsible solvents and processes, and three Nanoscale Science and Engineering Centers (NSECs). Centers are funded on a competitive basis to support focused efforts on the most important science questions requiring this level of concentration in order to make major advances.
- Through its Chemistry Research Instrumentation and Facilities (CRIF) program, CHE provides modern multi-user instrumentation, such as X-ray diffractometers and nuclear magnetic resonance

spectrometers; support for the development of instrumentation that permits new kinds of chemical measurements and broadens access; and support for large cyberinfrastructure projects and facilities, such as the National High Magnetic Field Laboratory.

The total portfolio of CHE in FY 2005 included 422 awards with a proposal success rate of 26 percent.

CHE priorities for FY 2007:

- **Maintaining a strong, flexible program of research and education grants that advance the frontiers of the chemical sciences.** Forefront research and education projects reflected in individual investigator and multi-investigator awards define future scientific and technological opportunities in the chemical sciences. CHE seeks to identify and nurture pioneering research that is potentially transformative, albeit high risk. The involvement in forefront research of undergraduate and graduate students, postdoctoral researchers, and beginning investigators builds national innovation capacity in the chemical sciences.
- **Special areas of emphasis** include: molecular basis of life processes (MBLP), sustainability, nanoscale science and technology, and homeland security (through the Engineering-led initiative on improvised explosive devices), aligning with multiple Administration R&D priorities.
- **Investments in cyber-enabled chemistry.** The development of databases, data mining tools, molecular visualization and computational capabilities, and remote and networked use of instrumentation and facilities, for example – promise to be transformative in the chemical sciences, allowing individuals and teams to address research challenges of unprecedented complexity working in entirely new ways.
- **Broadening participation.** Investments in the Research Experiences for Undergraduates (REU) and Undergraduate Research Collaboratives (URC) programs provide opportunities for far larger numbers of students, including first- and second-year college students and those at 2-year institutions, to create and communicate new knowledge in the chemical sciences and fuel the expansion of a culture of innovation in academic institutions. CHE will enhance efforts to increase the participation of women and underrepresented minorities in academic chemistry departments.

Changes from FY 2006:

- Research and education grants increase by $8.30 million to a total of $167.39 million. CHE will continue to support cutting-edge areas of chemistry, with emphasis on nanoscale science, MBLP, sustainability, and cyber-enabled chemistry.
- Instrumentation/Facilities increase by $430,000, to a total of $14.11 million. This includes enhanced investments in cyberinfrastructure to develop tools for cyber-enabled chemistry and contributions to the NHMFL and other facilities. Many of the investments in cyber-enabled chemistry will be made through the CRIF program, which also provides funds for multi-user instrumentation and instrumentation development.
- Chemistry Centers increase by $1.59 million, reflecting the establishment of one full-scale Chemical Bonding Center.

MATERIALS RESEARCH $257,450,000

The FY 2007 Request for the Materials Research Division (DMR) is $257.45 million, an increase of $14.54 million, or 6.0 percent, over the FY 2006 Current Plan of $242.91 million.

Materials Research Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Materials Research	**$240.09**	**$242.91**	**$257.45**	**$14.54**	**6.0%**
Major Components:					
Research and Education Grants	136.04	138.68	146.13	7.45	5.4%
Centers Programs	64.01	65.14	71.30	6.16	9.5%
Facilities	40.04	39.09	40.02	0.93	2.4%
National High Magnetic Field Laboratory (NHMFL)	24.00	24.26	25.00	0.74	3.1%
National Nanofabrication Infrastructure Network (NNIN)	2.55	2.52	2.55	0.03	1.2%
Other MPS Facilities	13.49	12.31	12.47	0.16	1.3%

Totals may not add due to rounding.

About DMR:

The Materials Research Division advances the intellectual frontiers of materials research which underpins innovation and national competitiveness. It enables the materials community to make new discoveries about the fundamental behavior of matter and materials; to create new materials and new knowledge about materials phenomena; to address questions about materials that often transcend traditional scientific and engineering disciplines and may lead to new technologies; to prepare the next generation of materials researchers; to develop and support the instruments and facilities that are crucial to advance the field; and to share the excitement and significance of materials and condensed-matter science with the public at large. DMR supports research over a broad range of subfields, including condensed matter and materials physics; solid state chemistry; polymers; ceramics; metals; electronic, magnetic and photonic materials; and materials theory. The division maintains a balanced portfolio of research topics through individual investigator grants, focused research groups, centers, and awards for instrumentation and user facilities. DMR programs support a variety of interagency and international partnerships to advance materials research and education.

The DMR portfolio has three major components: research and education awards, centers, and user facilities. Support for international collaboration and for broadening participation in materials research and education is integrated throughout the portfolio.

- DMR research and education awards comprise grants to individual investigators and small groups, and to teams of several investigators addressing complex problems in materials and condensed-matter research. DMR also supports six International Materials Institutes based at U.S. universities to enhance international cooperation in materials, and a program to support the acquisition and development of instrumentation for materials research. Partnerships for Research and Education in Materials are aimed at broadening participation in the materials research field by linking minority serving institutions with centers and groups at research intensive institutions. DMR will continue strong support for the seven existing partnerships, having added three during FY 2006.

- Materials Research Science and Engineering Centers (MRSECs) address major interdisciplinary problems in materials and condensed-matter science. DMR will continue support for 29 MRSECs in FY 2007, with three phasing out in FY 2006. The division also supports three Nanoscale Science and Engineering Centers (NSECs), a Science and Technology Center (STC) on Materials and Devices for Information Technology Research, and provides partial support for a further seven NSECs.
- DMR supports world-class facilities for high magnetic fields, synchrotron radiation, and neutron scattering, and provides partial support for the National Nanofabrication Infrastructure Network. Researchers use these facilities to address challenging problems across a very broad spectrum of science and engineering.

Facilities and centers comprise approximately 43 percent of the DMR portfolio in FY 2006. In FY 2005, DMR received 1,194 research proposals and made 266 awards for a success rate of 22 percent.

DMR Priorities for FY 2007:

Enhancing support for materials research programs that generate new ideas and novel materials and undergird innovative technologies. These core programs include awards to individual investigators, groups, interdisciplinary teams, and centers. Increased emphasis will be given to research on materials and phenomena at the nanoscale (including activities that address educational aspects and societal impact of nanotechnology); on biologically related materials including soft condensed matter; on computational materials research; and on materials for future cyberinfrastructure.

Broadening participation in materials research by maintaining vigorous programs for the participation of undergraduates, pre-college students and pre-college teachers in research, and by maintaining and enhancing partnerships that strengthen the links between institutions serving underrepresented groups and DMR-supported research teams, centers, and facilities.

Maintaining support for world-class user facilities while enabling the development of future user facilities and major instrumentation for synchrotron radiation, neutron scattering, and high magnetic fields. (For more detailed information about the National High Magnetic Field Laboratory, please see the Facilities chapter.)

Changes from FY 2006:

DMR will increase support for **research and education grants** by $7.45 million to a total of $146.13 million. The increase will enhance support for interdisciplinary research on nanoscale materials that also addresses educational needs and societal impact of nanotechnology. Support for research on cyberinfrastructure materials and biologically-related materials will also increase.

DMR will increase support for **centers programs** by $6.16 million to a total of $71.30 million. The increase will support a new Science and Technology Center for advanced polymer layer structures led by researchers at Case Western University. With funds from other centers being phased out, the increment will also support additional interdisciplinary groups at selected materials research centers addressing nanoscale research and the educational and societal aspects of nanotechnology.

DMR will increase support for **facilities** by $930,000 to a total of $40.02 million, maintaining critical support for state-of-the-art user facilities for synchrotron radiation, neutron scattering, and nanofabrication, and supporting increased operational costs at the National High Magnetic Field Laboratory. Funding for instrumentation will continue to be refocused to enhance support for the design and development of mid-scale instruments.

MATHEMATICAL SCIENCES $205,740,000

The FY 2007 Request for the Mathematical Sciences Division (DMS) is $205.74 million, an increase of $6.44 million or 3.2 percent above the FY 2006 Current Plan of $199.30 million.

Mathematical Sciences Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Mathematical Sciences	**$200.24**	**$199.30**	**$205.74**	**$6.44**	**3.2%**
Major Components:					
Research and Education Grants	200.24	199.30	205.74	6.44	3.2%

About DMS:

The Mathematical Sciences Division advances the intellectual frontiers of the mathematical sciences and contributes to advancing knowledge in other scientific and engineering fields and national competitiveness. It plays a key role in the training of the Nation's science and engineering workforce. Driven in part by increasingly sophisticated and readily available computing environments, advances in science and engineering are requiring more sophisticated mathematical and statistical tools.

NSF has a crucial role in the support of basic academic research in the mathematical sciences, providing almost 80 percent of all federal university-based support. In the core mathematical areas this percentage is much higher as 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. DMS plays a dominant role in developing the next generation of mathematical scientists, providing nearly all of the NSF support for graduate students and postdoctoral positions in the mathematical sciences.

DMS includes areas such as analysis, geometry, topology, foundations, algebra, number theory, combinatorics, applied mathematics, statistics, probability, mathematical biology, and computational mathematics. Awards in these areas support a variety of research projects, as well as for workshops, computing equipment and other research and education needs. In addition, DMS supports infrastructure, including national research institutes and postdoctoral, graduate, and undergraduate training opportunities. The DMS portfolio includes a variety of support modes and mechanisms:

- DMS research grants range in scope from individual-investigator awards to awards for multidisciplinary groups of researchers attacking problems of major scientific importance.
- DMS provides major support for education and training, particularly through Enhancing the Mathematical Sciences Workforce for the 21st Century (EMSW21), which focuses on 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.
- DMS provides core support for five mathematical sciences research institutes as well as major support for three other institutes, all funded on a competitive basis to serve as an incubator for new ideas and directions in the mathematical sciences and address the growing interface with other disciplines.

In FY 2005, DMS received 2,172 research proposals and made 687 awards, for a success rate of 32 percent.

DMS Priorities for FY 2007:

Single investigator as well as small group research grants form the core of the DMS portfolio and play a central role in advancing the frontier of knowledge. DMS emphasis areas include algorithm development and computational tools for large-scale problems of scientific importance, particularly stochastic or probabilistic models and modeling scientific phenomena that occur over a large range of spatial and temporal scales. Finding patterns in and, in general, understanding the structure of large data sets are fundamental problems.

Broadening participation in the mathematical sciences will emphasize the support of interactions and research networks among a diverse population that will include graduate students and researchers at a wide array of institutions. DMS will continue to emphasize the role of institutes in broadening the participation of researchers and students in the mathematical sciences.

Education and training activities include research experiences and mentoring activities aimed at increasing the number of U.S. students choosing careers in the mathematical sciences.

Mathematical Sciences Priority Area (MSPA). DMS will continue its strong support for the priority area, while initiating the mainstreaming of its activities in the DMS portfolio. The priority area will continue to have three major foci for DMS: (1) fundamental mathematical and statistical research, (2) interdisciplinary research that connects the mathematical sciences with other sciences and engineering, and (3) targeted investments in mathematical sciences training activities through research. Interdisciplinary investments will focus on challenges posed by large data sets, managing and modeling uncertainty, and modeling complex nonlinear systems.

Changes from FY 2006:

- **Support for the core** increases by $5.07 million in order to sustain the success rate for individual investigator proposals. Award size and duration will be maintained to the extent possible by providing adequate support levels for the most compelling projects and without reducing the success rate for unsolicited proposals. Investments in formal interdisciplinary partnerships through the MSPA will be redirected to unsolicited proposals and the fundamental mathematical sciences component of the MSPA, while retaining their spirit, and integrating them fully into the core with the continuing fundamental purpose of advancing the frontiers of knowledge. DMS will allocate approximately $1.0 million of this amount to activities related to computational science, specifically algorithm development for future computational tools.
- **Undergraduate research experiences in computational sciences** increases by $500,000, to $1.50 million total. This activity is designed to enhance computational aspects of the education and training of students in the mathematical sciences and to better prepare students to pursue careers in fields that require integrated strengths in computation and the mathematical sciences.
- **Enhancing the Mathematical Sciences Workforce in the 21st Century (EMSW21)** increases overall by $500,000. This will involve a realignment of EMSW21 by reducing the number of components to two, thereby consolidating and better focusing these efforts.
- **Support for the National Nanotechnology Initiative** increases by $170,000.

PHYSICS $248,500,000

The FY 2007 Request for the Physics Division (PHY) is $248.50 million, an increase of $15.37 million, or 6.6 percent, over the FY 2006 Current Plan of $233.13 million.

Physics Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Physics	**$224.86**	**$233.13**	**$248.50**	**$15.37**	**6.6%**
Major Components:					
Research and Education Grants	145.58	155.22	165.19	9.97	6.4%
Facilities	79.28	77.91	83.31	5.40	6.9%
Laser Interferometer Gravitational Wave Observatory (LIGO)	32.00	31.68	33.00	1.32	4.2%
Large Hadron Collider (LHC)	10.51	13.36	18.00	4.64	34.7%
Rare Symmetry Violating Processes (RSVP)	2.65	0.99	-	-0.99	-100.0%
National Superconducting Cyclotron Laboratory (NSCL)	17.50	17.32	17.60	0.28	1.6%
Cornell Electron Storage Ring (CESR)	16.62	14.56	14.71	0.15	1.0%

Totals may not add due to rounding.

About PHY:

PHY advances the intellectual frontiers of physics; contributes to advances in other scientific and engineering fields and to the ultimate benefit of the economy, health, and defense of the country; works toward early inspiration of the young, training the next generation of scientists and the high-tech workforce, and sharing the stimulation and understanding provided by science to the general public through the integration of research and education; and stewards the physics community to ensure it remains world-class as it evolves in the future. PHY supports research over a broad range of physics subfields, including atomic, molecular, optical, and plasma physics; elementary particle physics; gravitational physics; nuclear physics; astrophysics; theoretical physics; biological physics; physics cyberscience and cyberinfrastructure; accelerator physics; complex systems; and turbulence. The division maintains a balanced portfolio of research topics using appropriate modes of support and partnering across agency and national boundaries.

The PHY portfolio has two major modes of support: research and education grants and facilities.

- PHY research and education grants range in scope from individual-investigator awards to awards to major user groups, including groups with responsibility for experiments at national or international user facilities, and awards for frontier research efforts involving centers, institutes, and other multi-investigator collaborations.
- PHY also supports major world-class facilities that are needed by certain subfields to answer the highest priority science questions. (Additional information about PHY facilities is provided in the Facilities chapter of this document.)

In FY 2005, PHY made a total of 230 competitive awards and 541 continuing and supplementary award actions based on reviews from prior years. The funding rate was 37 percent for competitive actions.

PHY Priorities for FY 2007:

- **A strong, flexible program of research and education grants to create new ideas and technology and attract and train students** is the highest priority in overall stewardship of the portfolio. Emphasis will be given to increasing the support for cyberinfrastructure and cyberscience, theoretical research across the portfolio, and biological physics.
- **Elementary Particle Physics (EPP) Investment**. The opportunities for discovery in EPP and the challenges to addressing them are greater than at any time in the last half-century. The tools needed for breakthrough discoveries are more diverse and interdisciplinary, and NSF is well positioned to address the broader needs of EPP. By making the strategic, coordinated investment needed to realize the stunning opportunities laid out in numerous studies and plans, NSF will enable university researchers to participate fully in the emerging discovery period in EPP. The investment has three main components: the Energy Frontier, the Neutrino Frontier, and the Cosmic Frontier.
- **Physics of the Universe (POU)**, the highest scientific priority, addresses the compelling questions that have arisen at the interface of physics and astronomy and were posed by the National Research Council (NRC) report, "Connecting Quarks with the Cosmos." A subsequent National Science and Technology Council report, "The Physics of the Universe: A 21st Century Frontier for Discovery," outlines a national investment plan involving NSF, DOE, and NASA. Within NSF, POU is coordinated and supported by the AST and PHY Divisions. Activities include funding within the grants program, instrumentation development, and new facilities.

Changes from FY 2006:

- Research and education grants increase by $9.97 million to a total of $165.19 million. PHY will make a major new investment in EPP and related areas of POU research. PHY will continue to enhance support for cyberinfrastructure, theoretical physics, biological physics, and computational physics. Education and outreach activities will receive continued emphasis: enhancing K-12 science teacher training, expanding diversity within the research community, integrating research and education, including the training of new physicists.
- Facilities increase by $5.40 million to a total of $83.31 million. For detail, see the Facilities chapter. This includes:
    - An increase of $4.64 million for early operations (including data analysis support) of the LHC ATLAS and CMS detectors for a total of $18.0 million.
    - Increased support for operations of the Laser Interferometer Gravitational Wave Observatory (LIGO) and for advanced detector R&D at a total of $33.0 million, an increase of $1.32 million.
    - Increased support for operations of Michigan State University's National Superconducting Cyclotron Laboratory radioactive ion beam facility at a total of $17.60 million, an increase of $280,000, and for the Cornell Electron Storage Ring (CESR) facility at a total of $14.71 million, an increase of $150,000.
    - Phase out of the terminated RSVP project will be completed, a decrease of $990,000.

MULTIDISCIPLINARY ACTIVITIES $32,400,000

The FY 2007 Request for the Office of Multidisciplinary Activities (OMA) is $32.40 million, an increase of $2.72 million, or 9.2 percent, over the FY 2006 Current Plan of $29.68 million.

Multidisciplinary Activities Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Multidisciplinary Activities	**$29.80**	**$29.68**	**$32.40**	**$2.72**	**9.2%**
Major Component:					
Research and Education Grants	29.80	29.68	32.40	$2.72	9.2%

About OMA:

The Office of Multidisciplinary Activities enables and facilitates MPS support of particularly novel, challenging, or complex projects of varying scale in both research and education that are not readily accommodated by traditional organizational structures and procedures. This is done primarily in partnership with the five MPS disciplinary divisions 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 – within MPS or 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. 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.

Because OMA plays a catalytic role in initiating new multidisciplinary activities and enabling broadening participation, the portfolio contains few commitments from prior years. Almost all awards are managed in the MPS divisions with co-funding from OMA.

OMA Priorities for FY 2007:

Enabling the creativity of the MPS community by facilitating partnership-enabled multidisciplinary and high-risk research that extends the intellectual frontiers of the MPS disciplines. Such activities include fundamental multidisciplinary research at the interface between the AST and PHY Divisions that enables advances in our understanding of the physics of the universe; at the interface between the MPS disciplines and the biological sciences that provides insights into the molecular basis of life processes, bio-inspired materials, and biological physics; and by multidisciplinary teams of scientists, mathematicians, and engineers which leads to the development of next-generation instrumentation, particularly instrumentation at the mid-scale level, that enables fundamental advances across a wide spectrum of disciplines.

Catalyzing the development of a diverse, well-prepared, internationally competent, and globally engaged STEM workforce includes both MPS participation in Foundation-wide programs and MPS-centric activities that leverage the directorate's research investment. These activities enrich the education and training continuum at all levels and facilitate the formation of research-based partnerships that not only increase diversity and broaden participation in the STEM enterprise directly, but also build the physical and intellectual capacity of educational institutions, particularly minority serving institutions (MSIs), to produce larger, more diverse cohorts of U.S. graduates who are well prepared to both support and to lead the Nation's STEM enterprise in the 21st Century.

Changes from FY 2006:

Funding for **research-enabled broadening participation in the MPS disciplines**, including the MPS-wide **Research Partnerships for Diversity**, diversity-targeted outreach from MPS centers and facilities, and diversity-building partnerships with MPS professional societies, increases by $2.75 million to the level of $4.25 million. These co-investments with the five disciplinary MPS divisions enable research-based collaborative activities primarily between MPS-supported centers and facilities and MSIs. These collaborative interactions build research capacity of the MSI faculty, strengthen the research infrastructure of the MSIs, and engage, stimulate, retain, and develop an increasingly diverse cadre of students in the MPS disciplines at the undergraduate and graduate levels.

Support for **collaborative public education and outreach** activities at MPS-supported research centers and facilities will be maintained at the level of $3.0 million. This investment includes the MPS Internships in Public Science Education program and related activities that enable effective leveraging of the MPS research investment for public science education, and clear public articulation of MPS science themes such as Physics of the Universe.

The OMA investment in the **Research Experiences for Teachers** activity (RET) will be sustained at the FY 2006 level of $3.0 million, to provide more than 300 pre-service and in-service K-12 teachers with discovery-based learning experiences in the MPS disciplines.

Support for the restructured Foundation-wide **NSF Director's Distinguished Teaching Scholars** (DTS) program will be provided at the level of $500,000. This represents an increase of $500,000 from FY 2006 when the program did not solicit proposals. One important new facet of this activity will be its impact on broadening participation through recognition of diverse teacher-scholar role models. Support for the NSF-wide **GK-12** program increases by $530,000 to a total of $3.0 million.

Investment in cooperative **international research and training activities** will be increased by $200,000 to the level of $1.2 million, which will enhance the global competitiveness of U.S. scientists, engineers, and students. Included in this international portfolio are investments in the NSF-wide Pan-American Advanced Study Institutes, international research training networks, and opportunities for graduate students to establish and enrich international dimensions of their individual research and education programs.

All the above activities take place in the context of **disciplinary and interdisciplinary research**. OMA places particular emphasis on cooperative, high-risk research at the AST-PHY interface focused on Physics of the Universe, to be co-supported at the level of $2.50 million, and on innovative research in multidisciplinary areas that enhance our understanding of the molecular basis of life processes, biological physics, and bio-inspired materials, to be co-supported at the level of $2.0 million.

SOCIAL, BEHAVIORAL AND ECONOMIC SCIENCES $213,760,000

The FY 2007 Budget Request for the Directorate for Social, Behavioral and Economic Sciences (SBE) is $213.76 million, an increase of $13.85 million, or 6.9 percent, over the FY 2006 Current Plan of $199.91 million.

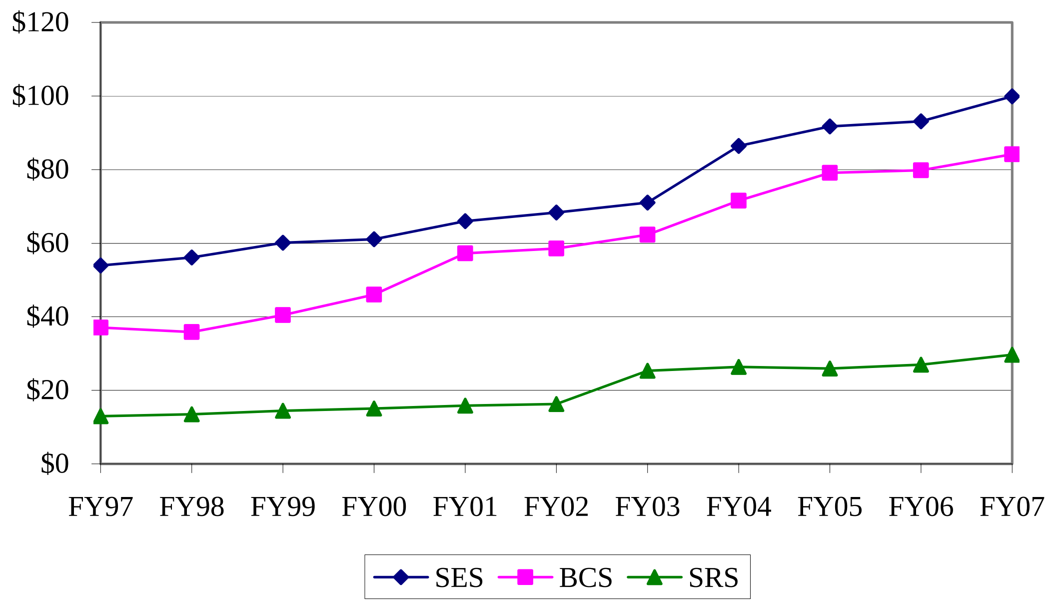
Social, Behavioral and Economic Sciences Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Social and Economic Sciences	$91.75	$93.15	$99.92	$6.77	7.3%
Behavioral and Cognitive Sciences	79.13	79.77	84.13	4.36	5.5%
Science Resources Statistics	25.92	26.99	29.71	2.72	10.1%
Total, SBE	$196.80	$199.91	$213.76	$13.85	6.9%

Totals may not add due to rounding.

The Directorate for Social, Behavioral and Economic Sciences supports research, infrastructure, and education primarily through grants to investigators at universities and other institutions. The research it supports, over the past decades, has resulted in substantial advances in our understanding of human and social development, of how people behave as individuals and as members of groups and other more formal organizations, and of key social and economic institutions and indicators. SBE also supports the collection and dissemination of statistics on the science and engineering enterprise.

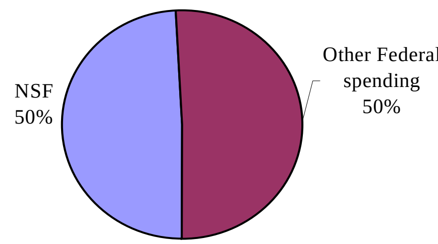
SBE Subactivity Funding
(Dollars in Millions)



RELEVANCE

SBE is a principal source of federal support for fundamental research on human cognition, behavior, 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 about half of federal support for basic research in the social sciences at U.S. academic institutions (reported by all federal agencies for FY 2003). In some fields, including anthropology, archaeology, political science, linguistics, non-medical sociology, and the social aspects of psychology, SBE is the predominant or exclusive source of federal basic research support.

Federal Support for Basic Research in the Social Sciences at Academic Institutions (excludes the Psychological Sciences)



The SBE Directorate supports government-wide and cross-NSF priorities and initiatives through its ongoing funding of work related to homeland security, disaster recovery, education and learning, the health of the economy, networking and information technology, ecology, climate change, biotechnology, nanotechnology, and similar areas. Basic research improves our capacity to assess, prevent, respond to, and recover from terrorist activities and natural disasters. Topics of recently funded research include: brain activity associated with truth and deception; the influence of fear on perceptions and decision making; network modeling; rebuilding from disasters; and the effects of terrorist assaults and natural disasters on people removed from physical harm but emotionally engaged with those who have directly suffered. With major support from the SBE-managed Human and Social Dynamics priority area and SBE's core programs, NSF recently announced new Small Grants for Exploratory Research (SGER) awards to study the impact of Hurricane Katrina on people and social systems in the hard-hit Gulf Coast region. SGER awards are limited in size and support exploratory, high-risk research and have proven to be especially well-suited for rapid-response situations in which the need for timely response is crucial in order to capture time-sensitive and perishable data. SBE previously used SGERs effectively to field research teams in the aftermath of both the September 11th terrorist attacks and the 2004 Indian Ocean tsunami.

Other recently funded projects investigate the human dimensions of ecological issues such as climate change and the social and ethical issues that surround advances in nanotechnology. SBE also provides statistical data for critical analyses of the role of foreign citizens in the U.S. science and engineering workforce. In addition, SBE awards foster the development of new information technology systems and software, the sharing of data within and across disciplines, the development of new social research infrastructures, and education at all levels in the SBE sciences.

SBE's Division of Science Resources Statistics (SRS) is the federal statistical agency responsible for the compilation and analysis of data on the science and engineering enterprise. SRS conducts, analyzes, and publishes survey results relating to research and development (R&D) funding and facilities, the science and engineering workforce, and workforce education. SRS also gathers information on the international science and engineering enterprise and uses available information to describe the U.S. role in a globalized economy. SRS activities and products provide critical benchmarking information on R&D, the S&E workforce, and the outputs of the S&E enterprise such as patents and scientific publications. SRS provides access to a variety of data on science and engineering through its website and online databases.

Findings from SRS studies have long helped shape the development of the Nation's educational and science policy agendas.

Summary of Major Changes by Division	*(Dollars in Millions)*
FY 2006 Current Plan, SBE……………………………………………………………....................	**$199.91**

Social and Economic Sciences +$6.77

$2.72 million in funding increases will support work connected with science metrics, $1.75 million will maintain funding for the Innovation and Organizational Change (IOC) program, and $2.30 million will provide additional support of core SES disciplines.

Behavioral and Cognitive Sciences +$4.36

An increase of $1.36 million will be used in concert with SRS and SES to foster the development of policy-relevant science metrics. The remaining $3.0 million will be used to strengthen core disciplinary research, allowing an increase in funding rates.

Science Resources Statistics +$2.72

Increased funding will support science metrics activities.

Subtotal, Changes +$13.85

FY 2007 Request, SBE.......................................…………………………..............……………...$213.76

Summary of Major Changes by Directorate-wide Investments	*(Dollars in Millions)*
FY 2006 Current Plan, SBE……………………………………………………………....................	**$199.91**

<u>Advancing the Frontier</u> **+**$10.26

SBE's disciplinary and interdisciplinary research will increase by $10.26 million to support frontier-setting social, behavioral, cognitive, and economic research. Of this increase: $4.43 million will support the BCS and SES Divisional priorities, as highlighted in each division's chapter; $4.08 million supports Science Metrics activities in conjunction with the SRS Division's increase of $2.72 million; and $1.75 million will maintain funding for the IOC program, formerly managed by another directorate. Within the core increase, $500,000 will support emerging frontier collaboration with BIO to begin a new Biology and Society program.

<u>Education, Workforce, and Broadening Participation</u> **+**$0.13

SBE will sustain investments in the integration of research and education through ADVANCE, CAREER, IGERT, GK-12, and REU (50 percent of all SBE's REU site students are underrepresented minorities); graduate students dissertation research; and mid-career social science training in emerging technologies. In addition, SBE will enhance strategic institutional collaborations to broaden participation of underrepresented minorities in the SBE sciences. SBE will continue to support core research to increase fundamental understanding of education and workforce development (e.g., early science education and the science of learning; patterns of development in student's educational and career choices; research on S&E climate, incentives and rewards, labor markets, and organizational variables in the workplace). The FY 2007 increase will strengthen these education and workforce efforts.

Instrumentation and Infrastructure +$3.34

Science Resources Statistics (SRS) funding increases by $2.62 million. This increase will support research, models, and analyses related to Science Metrics, which require accurate, high quality information on all aspects of the R&D infrastructure and innovation in the U.S., the globalization of R&D, and the S&E workforce. An increase of $720,000 will support fundamental research infrastructure, including major longitudinal and repeated cross-section surveys, and secure data enclaves, resources that are critical to understanding the causes of such phenomena as changing patterns of employment, political participation, attitude formation, and family structures.

Organizational Excellence +$0.12

Funding for Organizational Excellence includes $100,000 for Science Metric activities. These investments also provide support for Intergovernmental Personnel Act appointments and contractors performing administrative functions.

Subtotal, Changes +$13.85

FY 2007 Request, SBE.......................................………………………….............……………...$213.76

Science Metrics

Within the FY 2007 Request, $6.80 million is allocated for Science Metrics. The goal is to reach a point where the Nation's public and private sectors are able to reliably evaluate returns received from past R&D investments and to forecast likely returns from future investments. SBE is beginning this initiative in FY 2006 by allocating $2.60 million to develop the data, tools, and knowledge needed to foster a new science of science policy. SBE will conduct three workshops and fund new research on the dynamics of innovation at the individual and organizational level. Improving the science in this area will lead to new understandings of the individual and social dynamics that underlie successful innovation as well as to better understanding of the relationship between workforce training and returns on research investments. Understanding the dynamics of innovation is also important to developing valid metrics and to deciding on fruitful R&D investment policies.

Beginning in FY 2007, there will be two research aspects to SBE's long-term initiative in this area. The first focuses on data and involves the improvement and expansion of science metrics. Included here is research to better identify, characterize, and measure indicators of research investments and returns to these investments. Efforts in this area will include enhancing surveys the SRS Division now conducts to improve the comparability, scope, and availability of international data. Another goal is to reach out to the private sector as well as to academic researchers. In addition, this undertaking will be coordinated with efforts in other nations and international agencies addressing similar concerns and will enhance our understanding of the globalization of science and technology.

The second research aspect focuses on producing usable knowledge. Efforts in this area will include model building and the development of econometric and other statistical tools tailored to the problem of understanding innovation and returns to science investments. Qualitative and focused studies that bring tools and data together around such problems as understanding how innovation occurs and why some science investments pay off while others do not will also be supported. This integrated approach will aim at understanding and assessing both the factors that determine returns to R&D investments and the underpinnings and ramifications of innovation among individuals, organizations, and societies. Cross-national perspectives on both dimensions will be encouraged. Progress will, among other things, require identifying the stages and feedback mechanisms that influence R&D directions, processes, products and outcomes, and their relationships to individual, economic, and social well-being. In order to develop necessary metrics and achieve complex understandings, SBE will coordinate activities across its divisions and seek collaborations with other NSF directorates as well as with potential users of the research results.

Science Metrics research will range from single investigator to focused multi-science awards. In addition to these research efforts, funds will be invested in community building, in motivating a generation of researchers, and in training them in the skills needed to support knowledge in this area. The long-term aim is to create a cadre of scholars who can provide science policy makers with the kinds of data, analyses, and advice that economists now provide for setting fiscal and monetary policy.

NSF-WIDE INVESTMENTS

In FY 2007, the SBE Directorate will support research and education efforts related to broad, Foundation-wide investments in a number of areas, including NSF's multidisciplinary priority areas and the Administration's interagency R&D priorities.

SBE NSF-wide Investments

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biocomplexity in the Environment	$2.00	$2.00	$1.08	-$0.92	-46.0%
Climate Change Science Program	15.48	15.48	15.48	-	-
Cyberinfrastructure	20.39	20.54	20.54	-	-
Human and Social Dynamics	30.90	31.40	31.40	-	-
International Polar Year	-	2.40	5.00	2.60	108.3%
Mathematical Sciences	1.50	1.50	0.75	-0.75	-50.0%
National Nanotechnology Initiative	1.57	1.56	1.67	0.11	7.1%
Networking and Information Technology R&D	12.47	12.47	12.47	-	-

- **Biocomplexity in the Environment** support decreases by $920,000, to a total of $1.08 million, consistent with the planned phase down of this initiative. These funds will support research on the socioeconomic, cultural, and geographic dimensions of interactions between people and the natural environment, with a special focus on the dynamics of coupled natural and human systems.

- **Climate Change Science Program** (CCSP) support remains level with the FY 2006 Current Plan at $15.48 million. SBE's CCSP investments focus on the "Human Contributions and Responses" that study how people (individually, in groups, or through organizations) interact with natural environmental systems. In SBE, the SES Division supports projects that focus on decision making under uncertainty associated with climate change. The SES and BCS Divisions support CCSP-related research on the environment, the economy, and disasters.

- **Cyberinfrastructure** (CI) support remains at $20.54 million, level with the FY 2006 Current Plan. Substantial investments will be made in major social and behavioral science data collections and will address issues such as confidentiality protections and means for securing worldwide, user-friendly access. Breakthrough technologies, large-scale data capture research in progress, and the capacities of high performance computing will enable SBE sciences to grapple with and model complexity in ways that were heretofore impossible. Added investments will prepare scientists and educators to use, design, develop, and support cyberinfrastructure with the needs of the SBE sciences in mind.

- Support for the SBE-managed **Human and Social Dynamics** priority area totals $31.40 million, unchanged from the FY 2006 Current Plan. Almost every major challenge this country faces, ranging from climate change to terrorism to the need for an educated workforce, has at its core important human and social dynamics. HSD builds upon unprecedented opportunities for fruitful synergies across the social and behavioral sciences and other fields of sciences and engineering, by supporting multidisciplinary approaches to understanding the complex dynamics within and among human and social systems and their environments, at scales ranging from cellular to global and from nanoseconds to millennia. HSD aims to increase our ability to anticipate the complex consequences of change; to understand the cognitive and social structures that create and define change; and to help people and organizations manage profound or rapid change.

- SBE plans to participate in **International Polar Year (IPY)** activities through collaboration with the Office of Polar Programs and two programs it manages – Life in the Cold and Dark and Study of Environmental Arctic Change at a level of $5.0 million. SBE will support interdisciplinary research on human adaptation and change within polar environments that focuses on human/environment interactions from a range of perspectives, including physical anthropology and cognitive neuroscience, sociology and geo-political relations and economics, as well as science and technology studies. Human adaptations reflected in Native languages and cultures will be documented to create useful social databases. Furthermore, social and economic aspects of nutrition, mental-well being, and infectious diseases will also be examined. In addition, through its "gold-standard" General Social Survey, SBE will provide a survey vehicle for IPY specific questions, including questions that address how Americans' knowledge of the Polar regions is impacted by the attention given these regions during the IPY.

- **Mathematical Sciences** support decreases by $750,000, to a total of $750,000, consistent with the planned phase down of this initiative. These funds will support collaborative teams consisting of social/behavioral and mathematical/statistical scientists who are working to develop new mathematical and statistical techniques to advance research in the social and behavioral sciences. SBE also will support innovative training activities.

- **National Nanotechnology Initiative** (NNI) support increases by $110,000, for a total of $1.67 million. SBE's support for NNI investments enables research and educational activities that focus on issues of nanotechnology R&D and societal consequences, on both a domestic and global scale. The increase will enable continuing interdisciplinary participation in NSF-wide nanotechnology areas.

- **Networking and Information Technology R&D** (NITRD) support remains level with the FY 2006 Current Plan at $12.47 million. SBE's major investments in NITRD will continue to support (1) the social, economic, and workforce aspects of Information Technology (IT), focusing on the nature and dynamics of IT impacts on technical and social systems; and (2) human-computer interaction and information management to increase the benefit of computer technologies to scientists as well as non-science users.

QUALITY

SBE maximizes the quality of R&D it supports through the use of a competitive, merit-based review process. In FY 2005 the last year for which complete data exist, 97 percent of research funds were allocated to projects that underwent external merit review.

To ensure the quality of its processes for handling proposals and recommending proposals for awards, SBE convenes Committees of Visitors (COV) composed of expert external evaluators to review each program every three years. These experts assess the integrity and efficiency of the proposal review process and provide a retrospective assessment of the results of NSF’s SBE investments.

The directorate also receives advice from the Advisory Committee for the Social, Behavioral and Economic Sciences (SBEAC) on the missions, programs, and goals that best serve the scientific community; the promotion of quality graduate and undergraduate education in the social, behavioral, and economic sciences; and priority investment areas for research. The SBEAC meets twice a year and its Chair regularly consults with the SBE Assistant Director. Members represent a cross section of supported disciplines, with representatives from many sub-disciplines and members from academic institutions and industry. SBEAC includes women, underrepresented groups, and people from all geographic regions.

PERFORMANCE

NSF's FY 2007 budget is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals and ten investment categories highlighted in the FY 2003-2008 Strategic Plan. These were designed to better enable assessment of program performance and to facilitate budget and performance integration.

Social, Behavioral and Economic Sciences
By Strategic Outcome Goal and Investment Category
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Ideas					
Fundamental Science and Engineering	$141.20	$143.79	$154.04	$10.25	7.1%
Centers Programs	-	0.59	0.60	0.01	1.7%
Capability Enhancement	-	-	-	-	N/A
	141.20	144.38	154.64	10.26	7.1%
Tools					
Facilities	0.30	0.30	0.30	-	-
Infrastructure and Instrumentation	41.17	40.66	44.00	3.34	8.2%
Polar Tools, Facilities and Logistics	-	-	-	-	N/A
Federally-Funded R&D Centers	-	-	-	-	N/A
	41.47	40.96	44.30	3.34	8.2%
People					
Individuals	10.66	8.49	8.59	0.10	1.2%
Institutions	1.44	1.41	1.43	0.02	1.4%
Collaborations	-	0.99	1.00	0.01	1.0%
	12.10	10.89	11.02	0.13	1.2%
Organizational Excellence	2.04	3.68	3.80	0.12	3.3%
Total, SBE	$196.80	$199.91	$213.76	$13.85	6.9%

Totals may not add due to rounding.

Other Performance Indicators

The tables below show the estimated number of people benefiting from SBE funding, trends in award size and duration, number of awards, and funding rates.

Number of People Involved in SBE Activities

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Senior Researchers	2,484	2,508	2,666
Other Professionals	431	435	465
Postdoctorates	201	203	215
Graduate Students	1,410	1,424	1,515
Undergraduate Students	645	652	693
K-12 Teachers	10	10	11
Total Number of People	5,181	5,232	5,565

SBE Funding Profile

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Statistics for Competitive Awards:			
Number	1,006	1,013	1,050
Funding Rate	25%	25%	25%
Statistics for Research Grants:			
Number of Research Grants	649	642	680
Funding Rate	21%	21%	22%
Median Annualized Award Size	$84,050	$84,050	$84,100
Average Annualized Award Size	$109,762	$109,800	$110,000
Average Award Duration, in years	2.4	2.4	2.5

Recent Research Highlights

► **Documenting Endangered Languages:** Aware that roughly half of the 7,000 languages spoken worldwide could die out in a generation, NSF-funded researchers are struggling to document them before they are lost forever. Beyond the endangered languages' historical value, capturing and studying them is scientifically important for two reasons: to preserve the way languages encode cultural information and to understand the human mind through language variation. To achieve these goals, NSF is collaborating with the National Endowment for the Humanities on the Documenting Endangered Languages project, which incorporates a full range of sophisticated computing tools – including recording techniques that reveal the movement of muscles around the mouth as sounds are made and electronic resources that allow researchers to store and analyze digital images, sound files, and texts. In addition, the project has supported NSF's efforts to broaden participation in science by making four awards to tribal organizations or tribal members in 2005. (Managed by BCS).

► **Gold Standard Surveys:** Prominent among SBE's major research investments are three "gold standard" surveys — the American National Election Studies (ANES), the Panel Study of Income Dynamics (PSID), and the General Social Survey (GSS) — that have collectively figured in more than 10,000 books, articles and doctoral dissertations. Insights and surprises abound.

In a recent analysis of three decades of data collected by ANES, for example, scholars have found scant evidence of deep divisions among the American public on economic and social issues. Quite the opposite: divisions among states and counties have actually shrunk over the past 100 years. Meanwhile, much the same conclusions have emerged from studies of societal change using GSS data. Not only do most changes in social attitudes turn out to be slow, steady, and cumulative, but Americans are generally becoming more and more alike in their attitudes — even when they belong to groups that are supposedly at odds with one another.

For its part, the PSID reveals that even over short periods, households are *not* locked into a particular place in the country's wealth spectrum, but are economically quite mobile. These and other PSID data have implications for bankruptcy policy, understanding the use of credit card debt, and the like. (Managed by SES with support from SRS).

► **Human and Social Dynamics – Disaster Research:** Recognizing the importance of collecting ephemeral data, SBE has developed a quick response capability using Small Grants for Exploratory Research (SGER). This capacity, initially tested by the events of September 11, 2001, has proved invaluable in supporting research on the impact of the Indian Ocean tsunami in December 2004 and Hurricane Katrina in September 2005. NSF HSD and other SBE SGER grants, totaling more than $3.0 million, currently support more than 25 research teams studying the human and social dimensions of Hurricane Katrina.

Roadways in New Orleans flooded by Hurricane Katrina. Aug. 29, 2005. *Credit: Petty Officer 2nd Class Kyle Niemi, U.S. Coast Guard*

Although it is too soon for Katrina or tsunami related research to have yielded more than preliminary results, there are results from rapid response research following 9/11. For example, University of California-Irvine principal investigator Roxane Cohen Silver led a team of researchers who had collected mental and physical health data from an internet panel of U.S. residents outside New York City before 9/11. With SGER support, the team was able to re-survey the panel two months and six months after 9/11, to determine their responses to the event. The study revealed that symptoms of posttraumatic stress remained six months afterwards, although the symptoms had diminished from 17 percent (after two months) to six percent of the population. (SBE manages the HSD priority area).

► **Scientific Leaders**: North Carolina State University psychologist Pamela Martin's work on how social institutions influence behavior has led to the creation of a new after-school science education initiative for economically depressed communities.

Dr. Pamela Martin

With a Minority Post-Doctoral Fellowship in Developmental and Social Psychology from NSF, Martin's research addresses how churches and parents shape adolescents' racial identity. Her findings, with follow-up support from an NSF infrastructure "Starter" research grant, have resulted in The Southeast Raleigh Mathematics and Science Initiative: a partnership between NCSU, community organizations, and schools designed to deliver inquiry-based science and mathematics after-school programs to economically depressed communities. Preliminary results show that students' social skills and homework completion improved after involvement in the program, and the final grade assessments were uniformly and extremely positive for all students.

In May 2005, New York University sociologist Dalton Conley received the National Science Foundation's Alan T. Waterman Award, a prize given by NSF to the country's outstanding young scientist. Conley is the first sociologist and only the second social scientist to receive this award in its thirty-year history.

Dr. Dalton Conley

Conley was recognized for groundbreaking work elucidating some of the most complex features of human and social relationships. He is the author of a series of books and articles that rigorously explore social and personal inequality. Aided by an NSF CAREER award, Conley produced *The Pecking Order: Which Siblings Succeed and Why* (Pantheon Books), a groundbreaking book exploring how income, gender, health, and birth order in families result in "a tangled web" of inequalities that create a family's own pecking order. His research also demonstrates how certain social and economic conditions (e.g., levels of family wealth) are the basis of persistent differences in key areas of life, ranging from educational successes to the likelihood of relying on welfare.

SOCIAL AND ECONOMIC SCIENCES $99,920,000

The FY 2007 Request for the Division of Social and Economics Sciences (SES) is $99.92 million, an increase of $6.77 million, or 7.3 percent, over the FY 2006 Current Plan of $93.15 million.

Social and Economic Sciences Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Social and Economic Sciences	**$91.75**	**$93.15**	**$99.92**	**$6.77**	**7.3%**
Major Components:					
Research and Education Projects	$91.75	$93.15	$99.92	$6.77	7.3%

Totals may not add due to rounding.

About SES:

The Division of Social and Economic Sciences supports research and related activities aimed at a better understanding, both nationally and internationally, of political, economic, and social systems and how individuals and organizations function within them. It also supports research and other activities related to risk assessment and decision making by individuals and groups; the nature and development of the various sciences and technologies and their implications for society; methods and statistics applicable across the social, economic, and behavioral sciences; scholarly career development; and broadening participation in the social, behavioral, and economic sciences. Its programs include the classic disciplines of economics, political science, and sociology and such vibrant interdisciplinary fields as decision making and risk, law and social science, and science and technology studies. In many of its program areas, SES is the major if not the only federal funding source of basic social science research as well as an invaluable investor in fundamental data resources and methodological advancement.

About 73 percent of division funding is available for new awards and activities. The remaining 27 percent funds awards made in previous years.

The SES portfolio's major mode of support is research and education grants, including large-scale grants to support major infrastructure and focused interdisciplinary research teams. Grants range in scope from small supplements that allow undergraduates to participate in funded research to multi-million dollar survey grants that provide data used by thousands of researchers and that inform both business and governmental decisions.

SES HSD grants support large-scale interdisciplinary research teams that are exploring different aspects of decision making under uncertainty (DMUU) in relation to climate change.

SES coordinates the Ethics Education in Science and Engineering Program and supports, with other NSF directorates, the Online Ethics Center for Engineering and Science.

SES provides core support for national resource "gold standard" surveys, including the *Panel Study of Income Dynamics*, the *American National Election Studies*, and the *General Social Survey*.

SES infrastructure awards support leading interdisciplinary experimental laboratories in political science (Rice), economics (Cal. Tech., Harvard, South Carolina, Virginia) and decision science (Virginia Tech), including projects that bring experimental methods into the classroom (South Carolina, Virginia) and TESS (Time-sharing Experiments for the Social Sciences), which facilitates, for scientists across the country, research that seeks to use the internet as a virtual laboratory for conducting survey experiments (Pennsylvania, Michigan).

SES Priorities for FY 2007:

- Build a more effective **cyberinfrastructure** (1) by maintaining recently increased support for major social science surveys to counter lower response rates, improve quality, and take advantage of new technologies, (2) by supporting efforts to make supercomputing resources more accessible and more useful to social and economic scientists, and (3) through methodological planning and other investments aimed at improving or bringing online a wide range of cybertechnologies with the potential to transform social research.
- Work to build a **science of science policy** and better science metrics through research in and across core programs.
- Support the **Human and Social Dynamics** priority area to allow research on a scale that cannot be achieved through standard SES grants and to promote broadly interdisciplinary research that can foster major breakthroughs in understanding social change, organizational action, and decision making and risk.
- Increase support for **core** programs to improve funding rates and the scale of supported research.
- Continue to promote the development of rigorous qualitative research, particularly in conjunction with sophisticated quantitative analyses.
- Strengthen the **Innovation and Organizational Change** program to allow it to continue to effectively support rigorous social science research that promotes the creation of reliable evidence-based understandings of innovation in and the efficient operation of business firms, governmental organizations and non-governmental organizations.
- Invest in **education** for the social and economic sciences, particularly with respect to underrepresented groups.

Changes from FY 2006:

Support for the SES Division increases by $6.77 million. The increase includes:

- $2.72 million to be spent in concert with allocations by SRS and BCS to foster the development of policy-relevant science metrics.
- $1.75 million will be used to maintain funding for the Innovation and Organizational Change program, formerly co-supported by another directorate, which draws on sociological, social psychological, economic, and other perspectives to understand how business, educational and other organizations innovate and change in competitive environments.
- $1.65 million will be allocated to strengthen core disciplinary research.
- $650,000 will support Research Resources in recognition of the continually increasing costs of creating and maintaining data collections and anticipated research resource costs associated with the effort to develop improved science metrics.

BEHAVIORAL AND COGNITIVE SCIENCES $84,130,000

The FY 2007 Budget Request for the Division of Behavioral and Cognitive Sciences (BCS) is $84.13 million, an increase of $4.36 million, or 5.5 percent, over the FY 2006 Current Plan of $79.77 million.

Behavioral and Cognitive Sciences Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Behavioral and Cognitive Sciences	**$79.13**	**$79.77**	**$84.13**	**$4.36**	**5.5%**
Major Components:					
Research and Education Projects	$79.13	$79.77	$84.13	$4.36	5.5%

Totals may not add due to rounding.

About BCS:

The Division of Behavioral and Cognitive Sciences supports research and related activities that advance fundamental understanding in the behavioral, cognitive, anthropological, and geographic sciences. The division seeks to develop and advance scientific knowledge and methods focusing on human cognition and behavior, including perception, social behavior, language, and learning as well as across levels from neural through individual, family, and group levels. The division supports research and related activities that focus on human variation at the scales of society, culture, and biology, and how these variations and patterns develop over time. It 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. Through a convergence of new technologies and theoretical developments, behavioral and cognitive scientists are exploring new areas of inquiry and innovatively addressing longstanding questions. Strong core programs are complemented by active involvement in competitions that support collaborative and interdisciplinary projects to advance knowledge and build capacity across multiple fields.

About 72 percent of division funding is available for new awards and activities. The remaining 28 percent funds awards made in previous years. The BCS portfolio primarily supports research and education grants ranging in scope from individual-investigator awards for research based at the investigator’s home institution to larger group projects that span multiple disciplines and institutions. Major activities include:

- Integrating qualitative and quantitative analyses to understand cultures.
- Understanding fundamental human processes, including language, cognition, perception, and social interaction, in relation to adult and childhood developmental processes.
- Using a geographic framework for understanding social, political, and economic transformations.
- Using non-linear models to understand dynamics of human behavior on time scales from the instantaneous to the millennial.
- Creating platforms for annotating and archiving textual, audio, and video language samples, as well as accessing the material for analyses.
- Understanding human biological variation, human adaptation, and human ontology.
- Providing fundamental understanding of human social behavior, including attitude formation and change, social cognition, and personality processes.

- Facilitating research that advances understanding of the complexity in human-environmental interactions.

Within BCS, the core disciplinary program, "Children's Research Initiative/Developmental and Learning Sciences," will include larger scale investments in "Integrative Research Activities for Developmental Science" (IRADS) that will increase understanding of cognitive, linguistic, social, cultural, and biological processes related to child and adolescent development and learning. Through support of basic research, the behavioral and cognitive sciences are informing understanding of disasters such as Katrina, threats such as Avian flu, and chronic and emerging health issues such as obesity.

BCS Priorities for FY 2007:

Initiatives within Behavioral and Cognitive Sciences include special competitions for investigating human and social dynamics, for documenting endangered languages, for understanding child learning, and for studying human origins. Cyberinfrastructure investments will continue to provide significant opportunities for breakthroughs in cognitive and behavioral sciences. New methods are transforming how we understand the links between behavior, cognition, and their biological substrates. These advances are strengthening the core programs and their relations to each other.

- Support the **Human and Social Dynamics priority area** by funding large-scale, transformative interdisciplinary research on human action and development, as well as organizational, cultural, and societal adaptation and change.
- Advance fundamental knowledge of endangered human languages through the joint NSF-National Endowment for the Humanities-Smithsonian Institution initiative, **Documenting Endangered Languages**, including support for research on endangered Arctic languages during the **International Polar Year.**
- Increase basic knowledge about the complex biological, physical, and behavioral interrelationships that led to the development of the human species, and that are responsible for both the shared and variable features that characterize living human populations, through the **Human Origins** activity.
- Integrate the development of **cyberinfrastructure** with advances in the fundamental understanding of the complexity of human behavior to addresses critical national needs.
- Enable the transformation of behavioral and cognitive sciences by supporting new research methods to investigate the **links between behavior and its biological bases**.
- Inform critical national security efforts, such as countering **improvised explosive devices,** through collaboration with the Directorate for Engineering.
- Support core research to increase fundamental understanding of **broadening participation** in the scientific community and support training activities focused on individuals, institutions, and collaborations.
- Contribute to understanding **science and engineering innovation** as an internal individual process through supporting cognitive science and cognitive neuroscience research.

Changes from FY 2006:

Support for the BCS Division increases by $4.36 million. This includes:

- $1.36 million to be spent in concert with allocations by SRS and SES to foster development of policy-relevant science metrics.
- The remaining $3.0 million will be allocated to strengthen core disciplinary research, allowing the funding of additional proposals for an increase in success rate.

SCIENCE RESOURCES STATISTICS $29,710,000

The FY 2007 Request for the Division of Science Resources Statistics (SRS) is $29.71 million, an increase of $2.72 million, or 10.1 percent, over the FY 2006 Current Plan of $26.99 million.

Science Resources Statistics Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Science Resources Statistics	$25.92	$26.99	$29.71	$2.72	10.1%

About SRS:

The legislative mandate for the Division of Science Resources Statistics 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, web development and customer service to meet the statistical and analytical 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.

The funding portfolio for SRS includes ongoing, cyclical surveys, reports, and projects accomplished primarily through contracts and also a few standard grants. Funding is provided annually; SRS makes limited use of multi-year commitments. In FY 2007 SRS will:

- Continue to conduct surveys and engage in analytic activities that produce information for carrying out NSF's statutory mandate, for meeting NSF strategic goals, and for developing *Science and Engineering Indicators* and *Women, Minorities and Persons with Disabilities in Science and Engineering*. In FY 2007, SRS will continue activities designed to improve the relevance and quality of the data it collects and the information it disseminates. Such activities will lead to further quality improvements and additions to current activities in subsequent years.
- Improve the *Survey of Graduate Students and Postdoctorates in Science and Engineering* with initial implementation of redesigned components of the survey after significant pilot and testing activities.
- Continue support and analysis of a module on the *General Social Survey*, which is a "gold standard cross-sectional survey" supported by the SES Division, to obtain high quality information on public understanding and knowledge of science and technology. This effort is one of a series initiated by SRS beginning in FY 2004 to significantly improve the quality of information obtained on the public understanding of science that is used in the *Science and Engineering Indicators* report.
- Continue collection and dissemination of breakthrough data collections on the characteristics of cyberinfrastructure in the nation's academic and biomedical facilities. First time ever data were collected in FY 2004 and similar data with an updated questionnaire were collected in FY 2006.
- Maintain continuous improvement in the relevance and quality of all its products. Priorities for FY 2007 are implementing the results of prior methodological, analytical and planning activities directed

toward improving the quality, relevance, timeliness, and accessibility of all SRS products, including implementing redesigns and improvements to major components of current SRS surveys and continuing to explore the feasibility of new information collection efforts initiated in prior years.
- Enhance and expand existing on-line systems for user access to SRS data.
- Continue efforts to enhance information on S&E in Asia and the globalization of the S&E enterprise.

SRS Priorities for FY 2007:

As the office responsible for the primary data on the U.S. scientific and engineering workforce, SRS will:

- Conclude the 2006 cycle of data collections for the *National Survey of College Graduates, National Survey of Recent College Graduates,* and the *Survey of Doctorate Recipients*. Data from the three surveys comprise the Scientists and Engineers Statistical Data System (SESTAT). Dissemination of data from the 2006 surveys will begin in FY 2008. A number of methodological improvements based on experiments and experience in the 2003 cycle were implemented in 2006.
- Develop and implement pilot activities to gather information about individuals in postdoctorate positions, including individuals with foreign doctorates.
- Continue research and methodological activities begun in FY 2005 to improve the relevance and quality of data collected on the conduct of research and development.
- Continue activities examining the present taxonomies in place for describing fields of study/science. SRS is leading a cross-agency effort to update the 1978 OMB Directive No. 16 – Standard Classification of Fields of Science and Engineering. Of major concern are developing crosswalks between existing taxonomies and any potential new taxonomy and developing methods to better include cross-disciplinary and multi-disciplinary fields.
- Plan and develop a draft of the *2008 Science and Engineering Indicators* report. Complete and release the *2007 Women, Minorities and Persons with Disabilities in Science and Engineering* report, including updates to the web version of the report as new data become available.
- Work with the Census Bureau and Office of Management and Budget to add a field of degree item to the *American Community Survey* to facilitate sampling for the National Survey of College Graduates in the next decade and enhance analysis of the occupations and income of those with S&E degrees.

Changes from FY 2006:

- Funding increases of $2.72 million to a total of $29.71 million for work connected with science metrics. SRS will significantly expand its efforts to redesign and enhance its data collections on the research infrastructure and the education and careers of the S&E workforce to ensure that the data collected begin to reflect the innovation process, the globalization of R&D and the increasingly collaborative and interdisciplinary nature of science and engineering.
- SRS will expand its long-term efforts to devise collection instruments that more accurately measure the economic output of R&D than presently captured in the Survey of Industrial Research and Development. Activities include: methodological research on how best to capture R&D activities in the service sector, the role of innovation, new forms of conducting R&D, the role of research collaboratives, and the globalization of R&D. These activities will be informed by the findings of the 2005 National Academy of Sciences review of SRS R&D surveys and by outreach activities.
- In FY 2007, SRS will begin implementing an integrated strategy directed toward gathering comprehensive data on postdocs.
- SRS will devote funding to enhance the SRS website and on-line databases to support a broad spectrum of user input workshops, test beds, and model building exercises.

OFFICE OF CYBERINFRASTRUCTURE $182,420,000

The FY 2007 Budget Request for the Office of Cyberinfrastructure (OCI) is $182.42 million, an increase of $55.30 million or 43.5 percent over the FY 2006 current plan of $127.12 million.

Office of Cyberinfrastructure Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Office of Cyberinfrastructure	$123.40	$127.12	$182.42	$55.30	43.5%

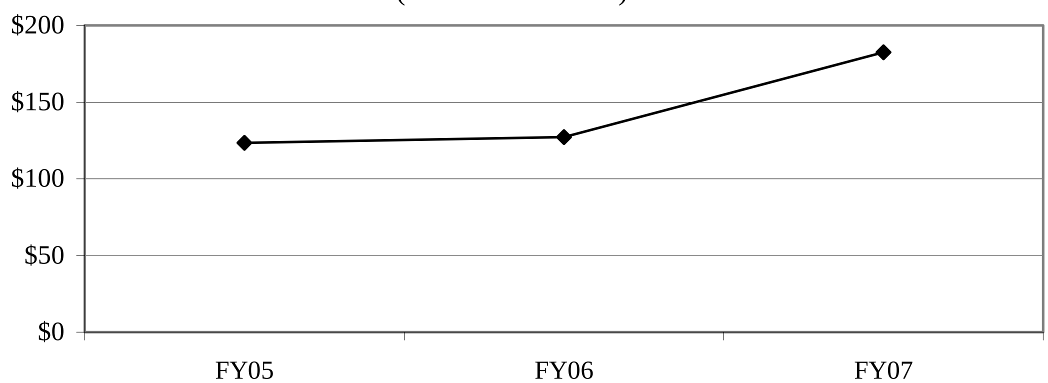
The Office of Cyberinfrastructure supports the acquisition, development, and operation of state-of-the-art cyberinfrastructure resources, providing cyberinfrastructure services that promote otherwise unrealizable advances in 21st century science and engineering research and education. These state-of-the-art tools and services also serve as engines for innovation, seeding the development of innovative IT products in a range of application areas. OCI was created in July 2005 in an organizational realignment that moved the CISE Division of Shared Cyberinfrastructure (SCI) into the Office of the Director. All SCI funds and programmatic activities as described in the FY 2006 request were transitioned to OCI.

OCI-supported cyberinfrastructure includes IT-based resources and tools such as supercomputers, high-capacity mass-storage systems, system software suites and programming environments, scalable interactive visualization tools, productivity software libraries and tools, large-scale data repositories and information management systems, networks of various reach and granularity, and an array of software tools and services that enhance usability and accessibility. OCI also supports the scientific and engineering professionals who create and maintain these IT-based resources and systems, and who provide the nation's researchers and educators with essential cyberinfrastructure services.

OCI activities directly respond to the President's high-end computing and cyberinfrastructure priorities and are key components in the Networking and Information Technology Research and Development (NITRD) priority.

OCI Subactivity Funding

(Dollars in Millions)



RELEVANCE

How does a protein fold? What happens to space-time when two black holes collide? What impact does species gene flow have on an ecological community? What are the key factors that drive climate change? Did one of the trillions of collisions at the Large Hadron Collider produce a Higgs boson? Can we create an individualized model of each human being for targeted healthcare delivery? How does major technological change affect human behavior and structure complex social relationships? What answers will we find – to questions we have yet to ask – in the very large datasets that are being produced by telescopes, sensor networks, and other experimental facilities?

These questions – and many others – are only now coming within our ability to answer because of advances in cyberinfrastructure. Once used by a handful of elite researchers in a few research communities on select problems, powerful cyberinfrastructure tools have become essential to future progress across the frontier of science and engineering. Today, scientists and engineers need access to contemporary cyberinfrastructure capabilities, such as distributed wired and wireless observing network complexes, comprehensive services that facilitate collaboration and communication, advanced data tools for mining, analysis, and visualization, and sophisticated simulation tools that permit exploration of phenomena that can never be observed or replicated by experiment. Fewer and fewer researchers working at the frontiers of knowledge can carry out their work without cyberinfrastructure tools of one form or another.

Recognizing that cyberinfrastructure capabilities are essential to advances in all science and engineering fields, NSF is currently developing a comprehensive cyberinfrastructure strategic plan entitled, *NSF's Cyberinfrastructure Vision for 21st Century Discovery* (www.nsf.gov/dir/index.jsp?org=OCI). This plan describes the agency's commitment to support the deployment of a well-engineered, scalable, cyberinfrastructure designed to evolve as the academic community's science and engineering research and education needs change. In implementation, NSF is promoting the development of a government-wide approach to cyberinfrastructure development and deployment, including the use of service-exchange agreements designed to enhance cyberinfrastructure resource sharing across federal agencies.

On NSF's behalf, OCI supports the development and deployment of cyberinfrastructure that is shared by all scientific and engineering disciplines and that promotes cyberinfrastructure interoperability here in the U.S. and abroad. About two thirds of NSF's investments in cyberinfrastructure are made in the Tools portfolio of the directorates and offices responsible for fundamental research and education in science and engineering, with the remaining third provided by OCI. Through coordinated planning and investments facilitated by NSF's Cyberinfrastructure Council, OCI provides economies of both scale and scope, ensuring that NSF's whole cyberinfrastructure portfolio is greater than the sum of its parts.

Summary of Major Changes in OCI Investments *(Dollars in Millions)*

FY 2006 Current Plan, OCI………………………………………………………………$127.12

Leadership Class High Performance Computing System Acquisition +$50.00

Increased funding will support the acquisition of a leadership-class High Performance Computing (HPC) system optimally configured to enable *petascale* (computing at rates on the order of 10^{15} floating point operations per second (petaflops) or working with very large datasets on the order of 10^{15} bytes (petabytes)) performance on important science and engineering problems. Complementing ongoing investments in mid-range HPC platforms, OCI will begin the four-year acquisition of a leadership-class platform that will allow the U.S. to retain its position as a world leader in scientific computing. Over four years, NSF anticipates investing approximately $200 million in this acquisition.

As described in the document *NSF's Cyberinfrastructure Vision for 21st Century Discovery*, this system acquisition is critical to the agency's multi-year plan to deploy and support a world-class HPC environment comprising the most powerful HPC assets available to the academic community. With access to petascale computing capabilities, researchers will be able to develop models that more accurately predict the occurrence of extreme weather events and to simulate the development of structure in the early universe. They will probe the structure of novel phases of matter such as the quark-gluon plasma and will examine the way proteins fold and vibrate after they are synthesized inside an organism. In fact, sophisticated *petascale* numerical simulations will permit scientists and engineers to perform a wide range of *in silico* experiments that are otherwise too difficult, too expensive or impossible to perform in the laboratory.

This acquisition will be conducted in close collaboration with sister agencies with a stake in HPC, through coordinating mechanisms such as those provided by NITRD and the proposed Leadership Computing Council. This allows participating agencies to leverage expertise and promising practices, to minimize duplication of effort, and ultimately promises to increase the architectural diversity of leadership-class systems available to researchers and educators around the country.

<u>Data- and Collaboration-Intensive Software Services</u> +$25.70

Science and engineering research and education have become increasingly data- and collaboration-intensive, as a result of the proliferation of digital technologies and pervasive networks through which scientific data, information, and knowledge are collected, generated, shared, or analyzed. The enormous growth in the availability and utility of science and engineering data, information, and knowledge is increasing scholarly research productivity, accelerating the transformation of research outcomes into products and services, and enhancing the effectiveness of learning across the spectrum of human endeavor.

OCI will support the development and provision of production-quality software services focused on strategic data- and collaboration-intensive functionalities. For example, data and collaboration services supported will: help researchers maintain data formatting standards and include or create metadata in real time; provide for experimental planning, execution, and post-analysis; support system monitoring and management capabilities; provide accessible, easy-to-use interfaces such as web portals through which researchers can access simulation software and domain-specific community code repositories; and enable teleobservation and teleoperation to provide scientists and engineers with remote access to experimental facilities, instruments, and sensors.

Concepts such as software clearinghouses will be explored to provide support throughout the software lifecycle, from concept and design through deployment and usage. OCI will support projects to: conduct applied research and development; perform scalability/reliability tests to explore tool viability; develop, harden, and maintain software tools and services where necessary; and harvest promising research outcomes to facilitate the transition of commercially-viable software into the private sector. Collectively, projects supported will be designed to provide for software interoperability.

Other Infrastructure and Tools -$20.40

Adjustments will be made in the current OCI portfolio to accommodate the strategic priorities described herein and in more detail in the document, *NSF's Cyberinfrastructure Vision for 21st Century Discovery*.

Subtotal, Changes +$55.30

FY 2007 Request, OCI…………………………………………………………………………$182.42

QUALITY

OCI maximizes the quality of the projects it supports through the use of a competitive, merit-based review process. The percent of funds that were allocated to projects that undergo external merit review was 98 percent in FY 2005, the last year for which complete data exist.

To ensure the highest quality in processing and recommending proposals for awards, a Committee of Visitors (COV) was held in June 2005. The COV was composed of qualified external evaluators, to review its portfolio for three years. These experts assessed the integrity and efficiency of the processes for proposal review and provided a retrospective assessment of the quality of results of NSF's investments.

In partnership with NSF's directorates and offices, OCI will receive advice from the Advisory Committee for Cyberinfrastructure (ACCI) (in formation) on such issues as: the mission, programs, and goals that can best serve the science and engineering community; how OCI can promote quality graduate and undergraduate education in the computational sciences and engineering; and priority investment areas in cyberinfrastructure. The ACCI will meet twice a year. Members from both academe and industry will represent a cross section of the science and engineering field, with representatives from many different disciplines. The ACCI will include a balanced representation of women, underrepresented minorities, and individuals from a range of geographic regions and institutions.

PERFORMANCE

The FY 2007 Budget Request is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals and the ten investment categories highlighted in the FY 2003-2008 Strategic Plan. These categories were designed as a mechanism to better enable assessment of program performance and to facilitate budget and performance integration.

Office of Cyberinfrastructure
By Strategic Outcome Goal and Investment Category
(Dollars in Millions)

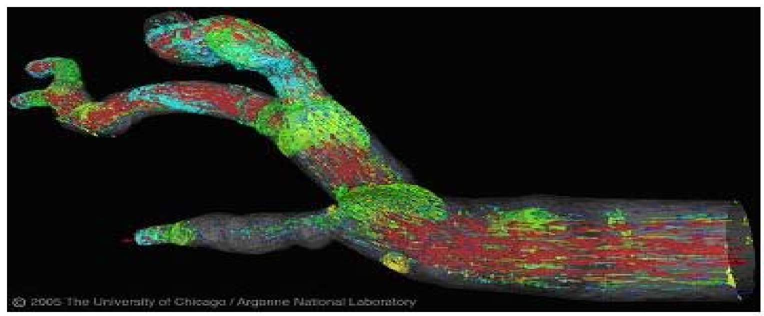
	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Ideas					
Fundamental Science & Engineering	$2.74	$9.85	$4.17	-$5.68	-57.7%
Centers	-	-	-	-	N/A
Capability Enhancement	-	-	-	-	N/A
	2.74	9.85	4.17	-5.68	-57.7%
Tools					
Facilities	-	-	-	-	N/A
Infrastructure and Instrumentation	113.01	103.74	164.72	60.98	58.8%
Polar Tools, Facilities and Logistics	-	-	-	-	N/A
FFRDCs	-	-	-	-	N/A
	113.01	103.74	164.72	60.98	58.8%
People					
Individuals	1.25	1.48	1.48	-	-
Institutions	0.22	-	-	-	N/A
Collaborations	5.51	10.00	10.00	-	-
	6.98	11.48	11.48	-	-
Organizational Excellence	0.67	2.05	2.05	-	-
Total, OCI	$123.40	$127.12	$182.42	$55.30	43.5%

Totals may not add due to rounding.

Recent Research Highlights

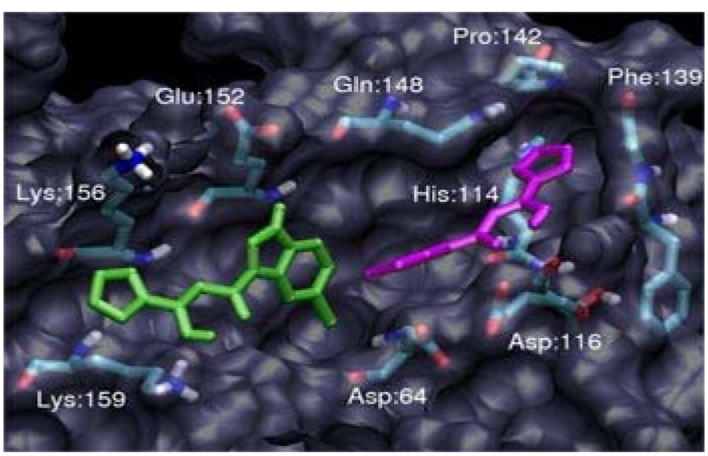
► **Forecasting Severe Storms:** Using OCI-supported TeraGrid resources at the Pittsburgh Supercomputer Center, researchers have accurately predicted thunderstorm activity 24 hours ahead of time—the highest resolution storm forecasts ever made. Such improvements will help affected regions better prepare for extreme weather events such as hurricanes, floods, winter storms and tornados. Those preparations, in turn, will help the U.S. reduce an economic toll that averages some $13 billion per year, and a human toll that averages nearly 1,000 deaths per year. This work was jointly supported by NSF and NOAA**.**

► **Human Blood Flow Study Uses the Combined Power of Multiple TeraGrid Sites:** In a development that could improve the effectiveness of medical diagnoses and surgical interventions, a team of researchers at Brown University has harnessed the computing and visualization resources at five OCI-funded TeraGrid sites to create a three-dimensional simulation of blood flow patterns in the human body. Their high-resolution model includes the 55 largest arteries in the body as well as 27 of the branch points where arteries divide.



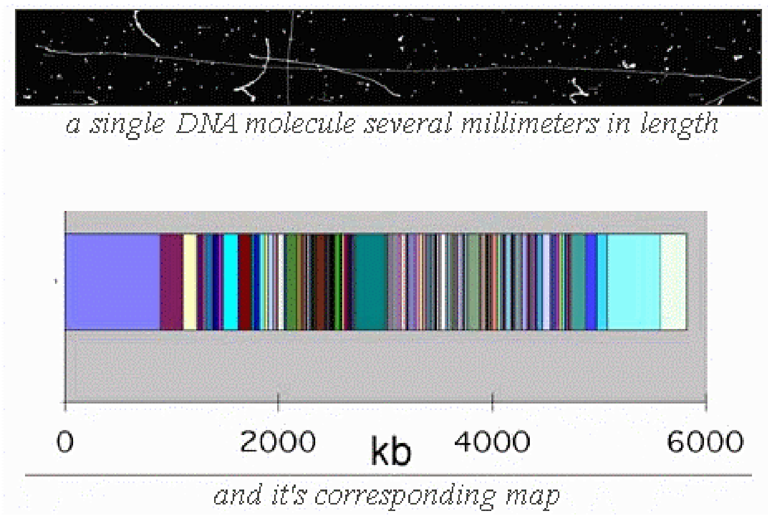
First ever simulation of the human arterial tree on NSF's Teragrid

► **Simulations of HIV Provide Fundamental Tools for Drug Discovery:** Using the San Diego Supercomputer Center's DataStar machine, a key component of the OCI-supported TeraGrid, researchers at the University of California at San Diego are developing sophisticated models of enzyme molecules essential to the functioning of the HIV virus. These simulations, in turn, are being used by Merck and Company to design and develop drugs targeting one particular HIV enzyme, integrase, which catalyzes a critical step in the HIV life cycle and enables cellular replication.

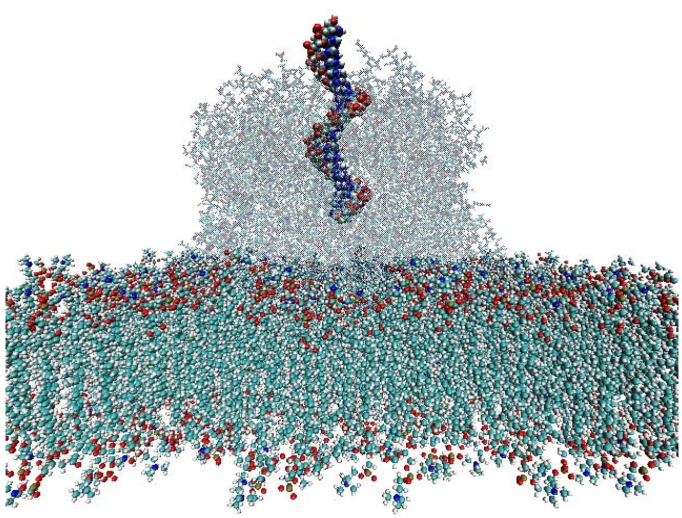


This graphic shows two potential inhibitors for the enzyme HIV-1 integrase.

► **Keeping Condor Flight Worthy:** NSF-funded computer scientists at the University of Wisconsin are continuing to develop and support "Condor": high-throughput computing software that allows scientists around the country and throughout the world to perform large-scale computations by harnessing the power of available computers, regardless of their physical location. In one dramatic example, researchers have recently used Condor to complete the first comprehensive search for structural variation within the human genome. Such variations were originally thought to occur only within cancers or other highly aberrant cell types, but this study demonstrates their existence in normal cells as well. These findings are significant not only because such alterations are linked with common diseases, but because they are also thought to be evolutionary launch pads for speciation.

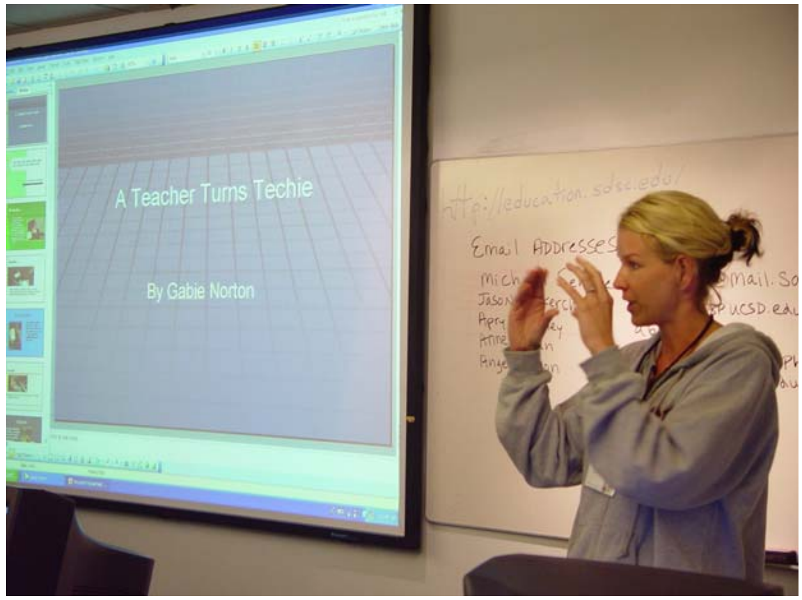


► **SPICE: Simulated Pore Interactive Computing Environment:** Researchers have recently linked systems at three US-based TeraGrid sites and two UK sites to run a computer model called SPICE, which simulates the migration of a DNA molecule through the nano-sized pore of a channel protein. This process, known as "translocation," occurs with both messenger-RNA and DNA. So a detailed knowledge of how it works is critical to many problems, from genetic information transfer to the design of high-throughput DNA screening. The SPICE simulation became tractable only with grid-enabled computational resources, which made possible to farm-out around 100 large-scale, non-equilibrium simulations across the transatlantic interconnected grid.



Translocation: Simulation of the migration of a DNA molecule through nano-size pore of a protein

► **Creating Cyber-savvy Teachers:** Between February 2005 to December 2005, the San Diego Supercomputer Center's (SDSC) TeacherTECH program reached 540 K-12 educators through monthly and summer workshops in science, technology, engineering and math. The participants represented all of San Diego County, from urban to rural, from the northern tip all the way to the border with Mexico. The sessions included TeacherTECH Workshops in both Technology Tools and Advanced Technology Tools, as well as TeacherTECH Series in both science and math. Many of the science series presentations are archived on SDSC's TeacherTECH site (http://education.sdsc.edu/teachertech) for viewing by teachers across the nation. Ten thousand people have visited the new TeacherTECH website since its inception in May 2005. The site includes standards-based curriculum submitted by workshop participants, science lectures, scientific visualizations, notes, resources and much more.



Other Performance Indicators

The table below shows the number of people benefiting from OCI funding.

Number of People Funded by OCI Projects

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Senior Researchers	314	315	350
Other Professionals	554	600	650
Postdoctorates	21	40	50
Graduate Students	162	170	200
Undergraduate Students	29	40	50
Total Number of People	1,080	1,165	1,300

However OCI investments directly impact a much larger number of researchers and educators within the U.S. and around the world who use OCI-supported cyberinfrastructure facilities, resources and tools. For example, OCI-funded cyberinfrastructure enables the work of an estimated 150,000 senior researchers, graduate students, undergraduate students and K-12 teachers annually.

The OCI funding profile is provided below.

OCI Funding Profile

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Statistics for Competitive Awards:			
Number	75	75	75
Funding Rate	65%	65%	65%
Statistics for Research Grants:			
Number of Research Grants	28	21	24
Funding Rate	41%	11%	12%
Median Annualized Award Size	$207,902	$365,408	$370,000
Average Annualized Award Size	$339,956	$404,209	$410,000
Average Award Duration, in years	2.3	2.6	2.7

OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING $40,610,000

The FY 2007 Budget Request for the Office of International Science and Engineering (OISE) is $40.61 million, an increase of $6.09 million, or 17.6 percent, over the FY 2006 Current Plan of $34.52 million.

Office of International Science and Engineering Funding

(Dollars in Millions)

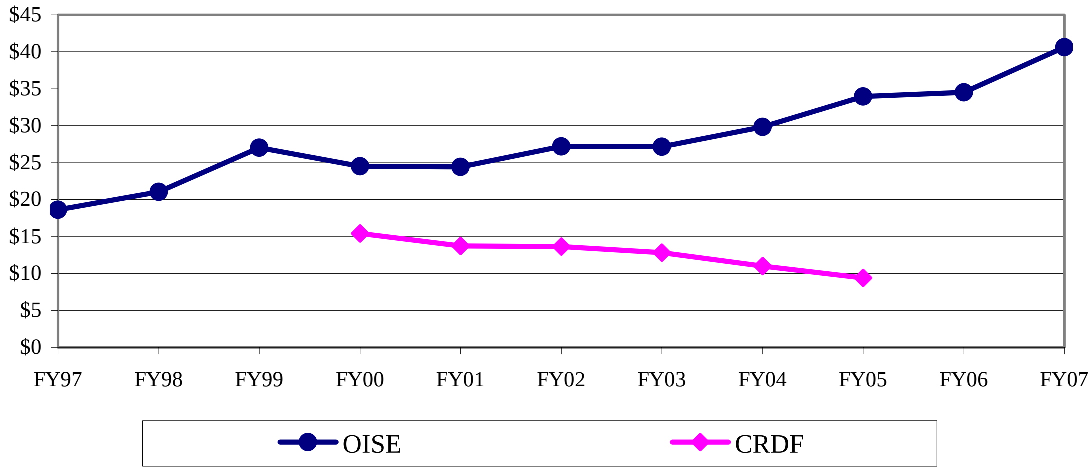
	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
OISE	33.96	34.52	40.61	6.09	17.6%
U.S. Department of State transfer	9.42	-	-	-	N/A
Total, OISE	$43.38	$34.52	$40.61	$6.09	17.6%

Department of State funds are for an award to the U.S. Civilian Research and Development Foundation.

The Office of International Science and Engineering 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 and national interests. Recognizing that scientific discovery is a global enterprise, OISE supports U.S. scientists and engineers engaged in international research and education activities in all NSF-supported disciplines involving any region of the world. In keeping with the National Science Board's call for NSF to make international science and engineering leadership a high priority and to strengthen the programmatic focus both in the core disciplines and in Foundation-wide activities, OISE was moved in October 2004 from the Directorate for Social, Behavioral and Economic Sciences to the Office of the Director.

OISE Subactivity Funding

(Dollars in Millions)



The bottom line shows additional funds provided by the U.S. Department of State 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), FY 2003 ($12.83 million), FY 2004 ($10.99 million), and FY 2005 ($9.42 million).

RELEVANCE

Science and engineering are international enterprises critical to American competitiveness and security. Bold exploration at the frontiers of science and engineering increasingly requires international partnerships. NSF – as the Nation's principal source of support to U.S. universities 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.

OISE programs and activities are designed to complement and enhance the Foundation's broad research and education portfolio and to overcome barriers involved in international collaboration. America's next generation of scientists and engineers must be able to work effectively in the global arena and marketplace. OISE supports programs that enable students and researchers to experience and engage in international research and educational activities across such areas as cyberinfrastructure, complex biological systems, natural hazards prediction and mitigation, nanotechnology, water resources, and math and science education. The Office carries out its functions by working closely with the other NSF directorates and offices as well as through its own programs. Additionally, OISE manages NSF's offices in Beijing, Paris, and Tokyo that report on and analyze in-country and regional science and technology developments and policies, promote greater collaboration between U.S. and foreign scientists and engineers, liaise with foreign counterpart agencies and research institutes, and facilitate coordination and implementation of NSF research and education programs.

Summary of OISE-wide Investments *(Dollars in Millions)*

FY 2006 Current Plan, OISE…………………………………………………………......................$34.52

Partnerships for International Research and Education +$7.00

In FY 2005 OISE launched a pilot program called *Partnerships for International Research and Education (PIRE).* This program funds innovative, international collaborative projects that link U.S. institutions and researchers at all career levels with top international collaborators to work at the most promising frontiers of new knowledge. With a limit of one submission per Ph.D.-granting U.S. university, roughly half of the 380 eligible institutions submitted proposals. Given the increasing importance of access to the best researchers and facilities around the world for the U.S. scientific and engineering community, OISE will build on the pilot program by soliciting in FY 2007 a new round of Partnership proposals. OISE will fund approximately 14 new Partnership awards representing an investment of $7.0 million per year for five years. OISE's total FY 2007 budget for PIRE (including continuing grants from the FY 2005 competition and new FY 2007 awards) will be $9.20 million.

International Research Experiences for Students +$1.00

A well-trained technical workforce is vital to maintaining U.S. innovation leadership and economic prosperity. To further enable U.S. undergraduate and graduate students to develop hands-on research skills in a global setting, OISE will invest in FY 2007 a total of $2.0 million in its program *International Research Experiences for Students* – an increase of $1.0 million over the FY 2006 Current Plan.

Other Disciplinary and Interdisciplinary Research -$1.91

This reduction offsets OISE's enhanced investment in the Partnerships for International Research and Education program. This decrease in funding will result in fewer workshops, planning visits, and co-funding of activities with other NSF directorates and offices.

Subtotal, Changes +$6.09

FY 2007 Request, OISE…………………………………………………………………......$40.61

OISE Priorities for FY 2007

During the past several years, OISE has implemented changes to define more clearly its programmatic priorities, to better link OISE to overall NSF goals, and to move toward larger, more innovative, and more competitive awards. OISE's key programmatic themes for FY 2007 are:

- Promoting research excellence through international collaboration; and
- Providing U.S. students, postdoctoral researchers, and junior faculty with international research and education experiences.

These themes reflect the fact that the process of discovery and the scientific/engineering workforce are increasingly global. The United States needs to engage actively in the global research community through collaborative research and must ensure that its young scientists and engineers are capable of operating in an international research environment and a global market.

The OISE portfolio, which is made up of awards to U.S. researchers and institutions, reflects programs managed by OISE and investments made in partnership with other NSF directorates and offices. In general, 55 percent of OISE's programmatic budget is available for new awards and activities. The remaining 45 percent funds awards made in previous years.

Specific emphases in FY 2007 are to:

- Continue major investments to promote research excellence through international collaboration. As noted above, OISE will launch a second program solicitation for the **Partnerships for International Research and Education**. In addition, OISE will fund the third year of the five-year pilot Partnerships program. OISE will partner with other NSF research directorates and offices and foreign research organizations to catalyze polar research in support of the **International Polar Year**. OISE will also invest in **cyberinfrastructure** research in order to enable U.S. scientists and engineers to benefit from leading experts, facilities, and data around the world. Other OISE investments to advance research excellence include: supporting workshops and planning visits to explore and develop collaborations; and co-funding and supplemental funding to highly competitive NSF awards that involve international work.

- Support **international research and education experiences** for U.S. early-career researchers, students, and teachers. This includes: the East Asia and Pacific Summer Institutes for U.S. Graduate Students (EAPSI); the International Research Fellowship Program for postdoctoral researchers; funding for undergraduate and graduate students, postdoctoral researchers, and early-career faculty to engage in international collaborative activities; and opportunities for K-12 students and teachers. For EAPSI, New Zealand will be added as a partner, in addition to existing partnerships with Australia, China, Japan, Korea, and Taiwan.

- Promote increasing America's science and engineering talent pool by **broadening participation** of women and underrepresented groups in NSF-supported international research and education activities, and of K-12 students and teachers participating in science and engineering activities that have an international dimension.

- Provide U.S. Government support to key **multilateral organizations**, thereby enabling U.S. scientists to participate in these global efforts. Multilateral groups expected to be funded include the Human Frontier Science Program, Global Biodiversity Information Facility, International Council of Science, and International Institute for Applied Systems Analysis.

- Continue efforts to develop greater collaboration with **developing countries**.

NSF-WIDE INVESTMENTS

In FY 2007, OISE will support research and education efforts related to broad, Foundation-wide investments in a number of areas, including NSF's multidisciplinary priority areas and the Administration's interagency R&D priorities.

These investments are based on a highly-focused and strategic framework that simultaneously strengthens core research, enhances interdisciplinary collaborations, promotes the integration of research and education, and collectively benefits the U.S. economy and citizenry. Within OISE, funding will support/contribute to ensuring that U.S. research and education objectives in these important areas benefit from international collaboration. OISE investments focus on innovative, catalytic initiatives, with the understanding that U.S. researchers with established international collaborations will seek funding directly from other NSF directorates/offices. Seeking to be responsive to broad NSF interests, recent OISE investments have supported all NSF-wide investment areas. For all of these, OISE investments support planning visits, workshops, principal-investigator-led collaborative research, international research experiences for U.S. students and postdoctoral researchers, and other catalytic activities.

Office of International Science and Engineering NSF-wide Investments

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biocomplexity in the Environment	$0.71	$0.25	$0.13	-$0.12	-48.0%
Cyberinfrastructure	0.22	1.00	1.05	0.05	5.0%
Human and Social Dynamics	0.06	0.50	0.50	-	-
International Polar Year	-	-	0.30	0.30	N/A
Mathematical Sciences	0.32	-	-	-	N/A
National Nanotechnology Initiative	0.72	-	-	-	N/A
Networking and Information Technology R&D	0.38	-	-	-	N/A

- Support to Biocomplexity in the Environment will be reduced from $250,000 to $130,000.

- OISE will coordinate with directorates and offices across the Foundation to ensure that the international dimensions of **Cyberinfrastructure** are highlighted and developed, and invest $1.05 million for international collaboration in cyberinfrastructure research and education activities.

- OISE will maintain its funding level of $500,000 for **Human and Social Dynamics** research where the potential for international collaboration is rapidly expanding.

- OISE will work closely with the Office of Polar Programs and participating directorates to ensure effective international partnering for research and education activities related to the **International Polar Year** (IPY) and will invest $300,000 for IPY-related programs.

- For **Mathematical Sciences**, OISE will support the initiation/development phases of international collaborations in this priority area if meritorious proposals are received.

- The opportunities and benefits of international collaboration in the areas of **National Nanotechnology** and **Networking and Information Technology Research and Development** have been targeted in the past. OISE support to catalyze new international collaborations in these areas will be considered on the basis of proposals received.

QUALITY

OISE maximizes the quality of research and education activities it supports through the use of a competitive, merit-based review process. Within the existing portfolio, the percentage of funds allocated to projects that undergo merit review was 50 percent in FY 2005 and is estimated at 50 percent in FY 2006 and 60 percent in FY 2007. The majority of projects that did not undergo external review were supplements that added an international dimension to projects already reviewed and funded in NSF disciplinary programs.

To ensure the highest quality in processing and recommending proposals for awards, a Committee of Visitors composed of external experts reviewed OISE in FY 2005 and affirmed the high quality of funded projects, of OISE's program portfolio management, and of OISE's unique enabling role within NSF regarding international activities and issues. These experts assess the integrity and efficiency of proposal review processes and provide a retrospective assessment of the quality of results of OISE's investments.

Additionally, the Advisory Committee for International Science and Engineering, composed of members representing the U.S. research and education community across disciplines, was established in June 2005. The Committee meets twice a year and advises the Office on its programs and the integration of international activities across the Foundation. The Committee includes a balanced representation of women, members of under-represented minorities, and geographic regions.

PERFORMANCE

NSF's FY 2007 budget is aligned to reflect funding associated with the Foundation's four strategic goals and ten investment categories highlighted in the FY 2003-2008 Strategic Plan. These were designed as a mechanism to better enable assessment of programs and to facilitate budget and performance integration.

Office of International Science and Engineering
By Strategic Outcome Goal and Investment Category
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Ideas					
Fundamental Science and Engineering	$33.22	$24.17	$29.26	$5.09	21.1%
Centers Programs	0.20	-	-	-	N/A
Capability Enhancement	-	-	-	-	N/A
	33.42	24.17	29.26	5.09	21.1%
Tools					
Facilities	-	-	-	-	N/A
Infrastructure and Instrumentation	-	-	-	-	N/A
Polar Tools, Facilities, and Logistics	-	-	-	-	N/A
Federally-Funded R&D Centers	-	-	-	-	N/A
	-	-	-	-	N/A
People					
Individuals	8.66	7.00	8.00	1.00	14.3%
Institutions	-	-	-	-	N/A
Collaborations	-	1.00	1.00	-	-
	8.66	8.00	9.00	1.00	12.5%
Organizational Excellence	1.31	2.35	2.35	-	-
Total, OISE	$43.38	$34.52	$40.61	$6.09	17.6%

The FY 2005 total for Fundamental Science and Engineering includes $9.42 million provided to NSF by the U.S. Department of State for an award to the U.S. Civilian Research and Development Foundation.

Recent Research Highlights

► **Wild Capuchin Monkeys Use Tools:** Working in northeastern Brazil, a team of researchers led by University of Georgia psychologist Dorothy Fragaszy has observed the first direct scientific evidence of tool use among a population of wild capuchin monkeys. Such tool use has long been known among chimpanzees in the wild. But this was the first such study of monkeys, and is thus of great importance for a comparative understanding of the cognitive, motor, and social underpinnings of routine tool use.

Brazilian Capuchin Monkey. Cr*edit: Dorothy Fragaszy Univ. of Georgia*

Co-investigators in the international study are from the Consiglio Nazionale delle Ricerche in Rome, Italy, the University of São Paulo, Brazil, and the Fundacão BioBrasil in Bahia, Brazil. Their work got underway when they heard new reports of wild capuchin monkey bands in Brazil that routinely use stones to pound open palm nuts. One of the Brazilian researchers had access to two of the sites where these bands lived. The result was the first opportunity to study the spontaneous development of tool use by a whole population of monkeys over a long period of time, in a completely natural setting.

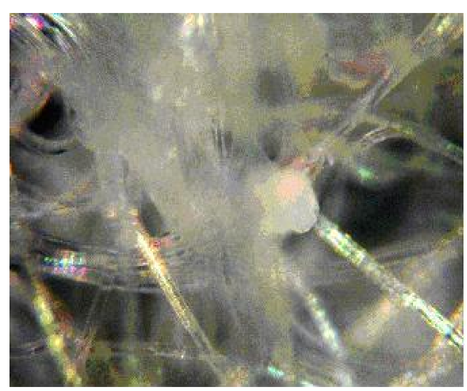
Still, a number of puzzles remain. For example, some of the cracking stones are large, water-smoothed rocks, which are not found in the immediate area. Where do they come from? Have the monkeys transported them over very long distances?

PASI on Materials for Energy Conversion and Environmental Protection. *Credit: R. P. H. Chang, Northwestern* University

► **PASI Program Backs Bright Ideas in Energy Research:** In October 2003, more than 60 graduate students and researchers from academia, government and industry met in Rio de Janeiro to make a cutting-edge plan for research on fuel cells and emissions control technologies. The Energy Conversion and Environmental Protection meeting was sponsored by the Pan-American Advanced Study Institutes (PASI), a program designed to stimulate training and cooperation between students and researchers in North, South, and Central America.

Jointly sponsored by NSF and the Department of Energy, PASI projects encourage an international and interdisciplinary approach to the most pressing research questions across the sciences. A PASI course generally lasts from two to four weeks and can consist of lectures, demonstrations, research seminars or discussions. In Rio, lecturers served as mentors and made presentations to graduate students representing more than ten countries. Unlike a traditional conference, the PASI courses provided students with a range of opportunities for interactive learning and hands-on experience. In turn, the students identified research questions, drew up collaborative research plans, and prepared joint proposals to seek funding for their projects. This project also contributed to broadening the participation of U.S. students from underrepresented groups as well as giving all U.S. participants a valuable international experience that would make them competitive in the global workforce.

► **Hi-Tech Textiles Repel Germs, Bugs, and Static Electricity!** In a triple whammy against germs, insect pests, and static electricity, scientists from North Carolina State University at Raleigh and the National Research Center in Cairo, Egypt have developed new fabrics that have antistatic, antimicrobial, and insecticidal properties.



Antimicrobial and insecticidal fabric. *Credit: Mohamed Bourham, North Carolina State University.*

The researchers treated the polypropylene-based fabrics with a special plasma that allowed them to attach synthetic antimicrobial compounds and natural insecticidal agents such as citronella, jasmine and sweet basil. Compared to ordinary fabrics, the new textile showed a 99.9 percent reduction in two common microorganisms, including E. coli, as well as ticks and other larger pests. In the future, the researchers hope to use similar technology in commonly used commercial fabrics made of cotton and wool. Potential applications for the fabrics include athletic apparel, clothing for people working in medical facilities, and protective garments for armed forces personnel.

► **Thinking Globally for the Cyberinfrastructure Workforce:** In an effort to prepare young researchers for a meaningful place in the modern world of globalization and technological change, the Pacific Rim Undergraduate Experience Program (PRIME) at University of California/San Diego is giving qualified students a chance to participate in international research and cultural experiences.

PRIME is funded by NSF in cooperation with the Pacific Rim Applications and the Grid Middleware Assembly, a consortium involved in the advancement and use of very high-speed computation. During the program's first year, nine American computer science students received support to work with research teams at some of the world's leading institutions in that field – among them, Osaka University's Cybermedia Center in Japan, Taiwan's National Center for High-Performance Computing, and Monash University of Australia. They participated in projects ranging from computer-aided visualization to the remote control of experimental equipment, to distributed computing. In future years, the program will expand in scope even further, branching into research areas such as cardiac physiology and earthquake-prepared engineering.

Nine U.S. students participated in PRIME 2004. *Credit: Peter Arzberger, Univ. of Calif./San Diego*

Aldovandra vesiculosa, an Australian aquatic plant. *Credit: GBIF*

► **Information on Global Biodiversity at Your Fingertips:** February 2004 marked the online debut of the NSF-supported Global Biodiversity Information Facility (GBIF), a digital database of scientific information on worldwide biodiversity. The portal gives access to more than 130 sources of information about the world's natural history collections, herbaria and other databases at the click of a mouse button.

Users can search the database by location, type of organism by scientific or common name, or other observational data and retrieve lists sorted by country. One important goal of the project is to digitize and make available data on organisms – often collected by researchers from developed countries – originating in developing countries, where such databases are generally scarce. In all, the GBIF provides access to more than 77 million records.

► **Alaska and Russia: Training Grounds for Tomorrow's Volcanologists:** As the role of volcanoes in climate change becomes clearer, and as the growing global population becomes ever more vulnerable to natural catastrophe, NSF is supporting efforts to understand and predict volcanic activity. To that end, John Eichelberger from the University of Alaska and Elena Vesna from Kamchatka State University have led an NSF-sponsored research and training project that brings American and Russian students to sites in Alaska and Russia – including the Kamchatka peninsula, home to the greatest density of volcanoes in the world.

U.S. and Russian collaborators on location. *Credit: John Eichelberger, University of Alaska/Fairbanks*

With students and faculty living together in remote camps and conducting day-long excursions on foot to study volcanic phenomena, the researchers are holding field courses in the region during three separate summers. These courses take advantage of the unparalleled teaching opportunities provided by active volcanism – especially when it comes to dramatizing the fundamentals of physics and chemistry.

Other Performance Indicators

OISE funding supports a significant number of individuals with a focus on early-career researchers. In FY 2005, awards managed by OISE supported estimated totals of 428 postdoctoral researchers, 601 graduate students, and 116 undergraduates. OISE's East Asia and Pacific Summer Institutes program alone placed 152 U.S. graduate students in research projects in Australia, China, Japan, Korea and Taiwan, while the Office's International Research Fellowship Program supported the research activities of 30 postdoctoral fellows from 15 states in 14 countries around the world. The table below shows the number of individuals supported through research awards where stipend and salaries are provided.

Number of People Involved in OISE Activities[1/]

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Senior Researchers	110	115	110
Other Professionals	25	25	35
Postdoctorates	35	35	55
Graduate Students	120	125	185
Undergraduate Students	50	56	90
Total Number of People	340	356	475

[1/] This table shows salary and stipend support awards only.

The funding rate for competitive awards in FY 2007 is estimated to decrease, chiefly due to plans to increase award size.

OISE Funding Profile

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Statistics for Competitive Awards:			
Number	335	330	320
Funding Rate	41%	45%	40%
Statistics for Research Grants:			
Number of Research Grants	71	70	85
Funding Rate	13%	20%	20%
Median Annualized Award Size	$14,996	$25,000	$30,000
Average Annualized Award Size	$90,980	$50,000	$100,000
Average Award Duration, in years	2.4	2.4	2.6

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OFFICE OF POLAR PROGRAMS $438,100,000

The FY 2007 Budget Request for the Office of Polar Programs (OPP) is $438.10 million, an increase of $48.76 million, or 12.5 percent, over the FY 2006 Current Plan of $389.34 million.

Office of Polar Programs Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
U.S. Polar Research Programs	278.27	322.68	370.58	47.90	14.8%
U.S. Antarctic Logistical Support	70.26	66.66	67.52	0.86	1.3%
Total, OPP	$348.53	$389.34	$438.10	$48.76	12.5%

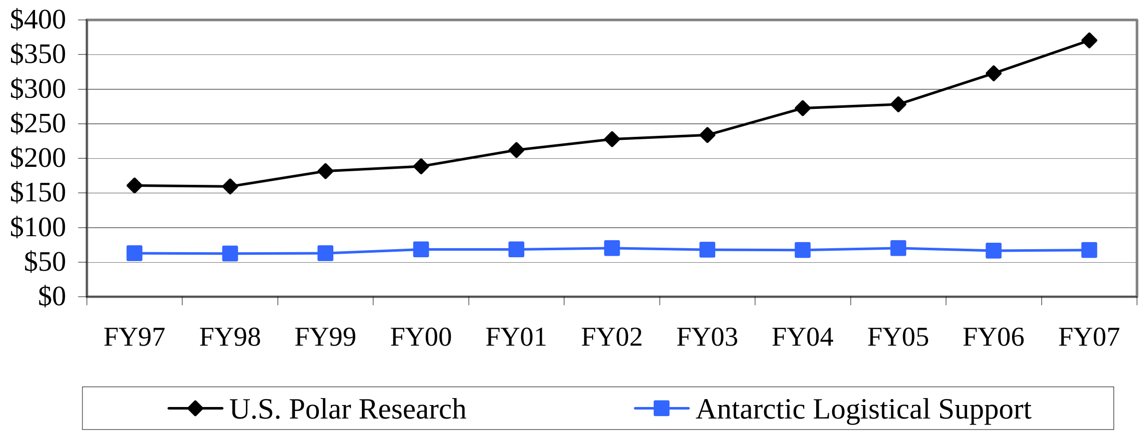
Totals may not add due to rounding.

The Office of Polar Programs supports most of the research in polar regions funded by the National Science Foundation. The Arctic and Antarctic are premier natural laboratories whose extreme environments and geographically-unique settings enable research on phenomena and processes not feasible elsewhere. For example, the cold dry environment and high altitude at the South Pole make it the world's best location for certain astrophysics measurements. Polar research provides insights into earth systems – the atmosphere, oceans and solid earth – that cannot be gained elsewhere, and study of the polar ice sheets reveals how the earth's climate has changed in the past. Polar regions also offer unusual opportunities for environmental research, as the sensitivity of polar ecosystems to small changes in climate renders them important bellwethers for potential future change. An additional area of unique current interest is that the polar regions provide information about how organisms adapt to environmental change. As in FY 2006, NSF has the responsibility for funding the costs of icebreakers that support scientific research in polar regions.

With the FY 2007 request, the OPP budget no longer includes funding for the Arctic Research Commission (ARC), which has been established as a separate activity within the Research and Related Activities account. For consistency, ARC funding is omitted from the total for OPP in FY 2005 and FY 2006. For further information, please see the Arctic Research Commission chapter.

OPP Subactivity Funding

(Dollars in Millions)



RELEVANCE

Research in polar regions offers opportunities for fundamental advances in each of the disciplinary sciences, ranging from the behavior of the earth's inner core to the formation of galaxies, from the biology of life in the cold and dark to how Arctic residents are affected by environmental change. In addition it addresses polar aspects of the global earth system – glacial and sea ice, terrestrial and marine ecosystems, the ocean, and the atmosphere – that help shape the global environment and climate. OPP funding will support the development and implementation of the enhanced observation systems needed to trace these shaping influences on a regional basis, as well as research to elucidate the interactions among them and how they impact the polar environment. The work will include study of the natural climate records from the past contained in ice cores and earth sediments. Much of this research will be carried out in collaboration with scientists in other countries, promoting international partnerships.

NSF provides interagency leadership for research planning as directed by the Arctic Research Policy Act of 1984. The NSF Director chairs the Interagency Arctic Research Policy Committee (IARPC) created for this purpose. In addition, per Presidential Decision Directive, NSF manages all U.S. activities in the Antarctic as a single, integrated program, making research possible in Antarctica by scientists supported by NSF and by U.S. mission agencies including the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, and the Department of Energy. The U.S. Antarctic Program supports the U.S. governance role through the Antarctic Treaty.

In FY 2006, funding responsibility for the U.S. Coast Guard's (USCG) three polar icebreakers was transferred to NSF, along with $48.0 million from the USCG's budget. NSF and the USCG work together to formulate operations and maintenance plans and associated funding requirements.

In FY 2006, NSF will initiate funding for research to be conducted during the International Polar Year (IPY) 2007-2008. The vision for IPY established by the National Academy of Sciences (NAS)/Polar Research Board includes an "… intense, coordinated campaign of polar observations, research, and analysis that will be multidisciplinary in scope and international in participation….that will benefit society by exploring new frontiers and increasing understanding of the key roles of the polar regions in globally linked systems."

As the lead agency supporting polar research, NSF is poised to provide U.S. leadership in this activity through the work of its grantees. The FY 2007 request will enable that leadership. Major emphasis in FY 2006 is being placed on **Study of Environmental ARctic CHange** (**SEARCH**), **Polar Ice Sheet Dynamics and Stability,** and studies of **Life in the Cold and Dark**, particularly at the genomic level. Work in FY 2007 will build on these themes and expand to new ones being identified in research community planning activities. NSF's Directorate for Education and Human Resources will participate actively in this work, as will most of the disciplinary-based research directorates in NSF.

Priorities for FY 2007:

International Polar Year

Study of Environmental Arctic Change (**SEARCH**). SEARCH is an interagency program established to study recent and ongoing change in the Arctic. The research community has identified establishment of a pan-Arctic observing system as key to advancing the science of SEARCH, both under IPY and on a longer-term basis. During FY 2007, OPP will give special emphasis to establishing a research-driven network of measurement systems in collaboration with other countries, including a network of human observations and indigenous knowledge in the Arctic that will create a long-term legacy for future generations of scientists and policy-makers.

Polar Ice Sheet Dynamics and Stability. OPP will make research and infrastructure investments to advance understanding of polar ice sheets and their connection to global climate change. Growth and decline of the Antarctic ice sheets has dominated changes of sea level of hundreds of feet in past glacial cycles, cycles whose characteristics will be studied in the planned West Antarctic Ice Sheet (WAIS) and Antarctic Drilling (ANDRILL) programs. The WAIS Divide ice-coring program will obtain climate records of the last 40,000 years with temporal resolution that allows for direct comparison with climate changes that took place in the Arctic. A complementary record of the last three million years will be obtained by ANDRILL, a program to core marine sediments from the Antarctic margin and determine ice sheet behavior and paleoenvironmental conditions. Preparations will also begin for exploration of the Gamburtsev Subglacial Mountains, considered the nucleation point of Antarctica's major ice sheets and an international focal point for IPY research.

Life in the Cold and Dark. OPP will fund research and required infrastructure to enable advances in understanding, particularly at the cellular and genomic level, of how life adapts and survives the polar cold and dark. Activities, as part of IPY, will support research in Alaska (particularly at Toolik field station), at Summit, Greenland, and in the McMurdo Dry Valleys of Antarctica during the polar night, a time when the extreme conditions have severely limited access by scientists in the past. Recently developed molecular techniques will be used to further advance scientific research.

Antarctic Resupply Options: The condition of the USCG polar icebreakers and the uncertainty regarding their future prompted OPP and the OPP Advisory Committee (OAC) to identify and study options for reducing demands on the ship-based logistics system and to develop contingency plans for dealing with a possible failure of that system. Funds are requested to begin implementation of several of the most promising options.

USCG Polar Icebreakers: The request includes funds to operate and maintain the *POLAR SEA* and the *HEALY*, including extraordinary maintenance needs identified the USCG, and to keep the *POLAR STAR* in caretaker status with a reduced crew pending the outcome of the National Academies of Science's study of the Nation's icebreaking needs.

Polar Programs Funding by Major Area

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Arctic Sciences	76.10	70.83	89.59	18.76	26.5%
Antarctic Sciences	46.19	42.81	52.53	9.72	22.7%
Antarctic Ops, Science Support, Logistics	216.79	208.42	228.61	20.19	9.7%
Polar Environment, Safety, and Health	0.25	5.13	5.92	0.79	15.4%
STC: Center for Remote Sensing of Ice Sheets	-	3.95	4.45	0.50	12.7%
USCG Polar Icebreaking[1/]	9.20	58.20	57.00	-1.20	-2.1%
Total, Office of Polar Programs	$348.53	$389.34	$438.10	$48.76	12.5%

[1/] Represents all funding provided to USCG. In FY 2005, in addition to payments to USCG, OPP paid $4.13 million to charter the icebreaker *KRASIN* to perform the Antarctic break-in and in FY 2006, in addition to payments to USCG, OPP estimates it will cost $9 million to charter the icebreaker *KRASIN* to perform the Antarctic break-in.

Summary of Major Changes by Major Area *(Dollars in Millions)*

OPP FY 2006 Current Plan……………………………………………………………… **$389.34**

Arctic Sciences

International Polar Year:
Fund a special competition for IPY and support for a broad range of smaller innovative projects that are responsive to the International Council for Science (ICSU) and NAS/National Research Council (NRC) guidelines; and fund a significant component of the Arctic Observing Network. This is a major IPY activity that leverages observing system investments made by international partners such as the European Union. +$8.30

Fund the Bering Sea Ecosystem Study (BEST) observation program, with an emphasis on developing a strong social science component. This program, relevant to IPY, was identified by the U.S. Arctic Research Commission as a high priority for development and support by NSF. +$1.46

Provide essential **logistics** to implement activities planned for IPY: Enable winter research at the LTERs at Toolik field station, AK, and Summit, Greenland; make investments in infrastructure to enable NSF's research community to more effectively utilize the Barrow Global Change Climate Research Facility; and support additional ship capabilities for marine-based research in polar oceans via contract or international partnership. +$8.00

Infrastructure:
Restore funding for a powerline upgrade in Barrow, AK. This was deferred from FY 2006 to FY 2007, due to unanticipated icebreaker costs. +$1.00

Antarctic Sciences

International Polar Year:
Fund a special competition for IPY and support for a broad range of smaller innovative projects that are responsive to the ICSU and NAS/NRC guidelines. Funding will increase for studying the dynamics of WAIS, a major IPY activity. Although WAIS is sensitive to global environmental change and it may contribute significantly to sea level rise in the future, parts of it remain poorly characterized. Increased funding will allow key observations in these sectors of this ice sheet and thus allow incorporation of these data into developing mathematical models of ice sheet dynamics. Funding will also increase for genomics in polar biology, another major IPY activity. Molecular and genetic methods are revolutionizing understanding of biology, and polar biology is no exception. This increase will support work to exploit genetic and molecular biology approaches toward understanding how organisms and ecosystems have adapted to the extreme conditions of the Antarctic. +$8.50

Initiate remote sensing of the previously unexplored Gamburtsev Mountains in the ice-covered interior of Antarctica. Although little is known about these mountains, they play a critical role in all models of the initial glaciation of Antarctica, a topic relevant to IPY. +$1.22

Antarctic Operations and Science Support

U.S. Antarctic Program Resupply: +$10.20

Funding for studies and projects responding to recommendations made by the OAC Subcommittee on U.S. Antarctic Program Resupply for diversification of the transportation system. The goal is to mitigate the single point failure mode associated with needing icebreaker, fuel tanker, and cargo ship access to McMurdo Station, Antarctica. Further investments will be made in studies, analyses, and small-scale proof of concept efforts to pursue promising options identified by OAC. Larger projects include the following:

South Pole Traverse: Implement at least one full-capacity traverse swing for surface supply of South Pole Station. The South Pole Traverse proof-of-concept was completed in early FY 2006. Funding for a full swing will enable the traverse to deliver the equivalent of approximately 25 LC-130 flights of cargo/fuel. This capability reduces the cost of fuel delivery at the South Pole, diversifies the transportation system and therefore reduces reliance on LC-130s in the event that this asset cannot be used due to weather or is otherwise unavailable or in too short a supply to complete all required tasking in a given season.

Fuel Storage Capacity: Provide additional fuel tanks at McMurdo to provide a two-year capacity by FY 2008 to mitigate the consequences of a failure in the McMurdo resupply. Building on design work that will be completed in FY 2006, the FY 2007 request will provide for procurement, delivery, and site preparation for additional fuel tanks at McMurdo Station. Construction will be completed in FY 2008. Additional fuel storage capacity at McMurdo Station will provide the flexibility to skip a year of fuel resupply should ice or logistics conditions make that necessary.

South Pole Station Airstrip: Purchase equipment for milling and compacting a South Pole Station airstrip capable of handling heavy-lift aircraft (e.g., C-17) flying fuel and supplies directly from off-continent. Together with the traverse, this will help decouple South Pole Station supply from McMurdo resupply, thereby reducing demands on cargo and tanker ship access enabled by icebreakers.

Program Offsets: Program offsets will be made in other areas to provide funding for Antarctic resupply projects: Funding will be deferred for the Williams Field Relocation Project (McMurdo aircraft landing area). This project involves constructing new access trails, airfield ramp areas and runways, as well as replacing buildings, for the LC-130 skiway. Deferring this project puts the program at eventual risk for reduced LC-130 operations should the ice on which Williams Field is currently located become unusable. Indefinite deferral is not an option as the ice will eventually calve into the sea. -$2.18

Funding for power management and energy distribution upgrades for South Pole Station will also be deferred. This work involves changes to the power distribution network for the Dark Sector. Deferring this work will limit the power available for the installation of instruments at the South Pole and will require administrative power management procedures for Dark Sector research projects.

Palmer Station Cargo Pier: +$2.31

Fund design studies for replacement of the cargo pier at Palmer Station, Antarctica. The pier at Palmer Station is approaching the end of its useful life. Without a usable pier, resupply and research vessel access to Palmer Station will be jeopardized. Funding for the initial phase of this project and funding for future construction will ensure access to Palmer Station.

International Polar Year: +$9.00

Provide essential **logistics** to implement activities planned for IPY. Planned activities include enabling winter research at the LTER in the Antarctic McMurdo Dry Valleys; and enhancing capabilities for deep field research, including purchase of surface traverse vehicles and contracts for aircraft to support deep field research. South Pole communications bandwidth will be increased by an order of magnitude (to 100 Gbytes/day), to better support physics and astronomy experiments.

U.S. Antarctic Logistical Support +$0.86

Funds for DoD-related costs associated with the Antarctic resupply projects discussed above, in the form of DoD engineering studies and increased airlift.

Polar Environment, Safety, and Health +$0.79

This section was established in FY 2005 to manage and oversee the environmental, safety, and health (ES&H) aspects of research and operations conducted in polar regions. The ES&H section has overall responsibility for guiding the implementation of both an environmental perspective that provides appropriate protection and stewardship of the environment; and a safety and health perspective, including oversight of medical activities, of OPP-sponsored activities in polar regions. Funding is included for safety and health measures in remote field research that will be conducted during IPY.

Science and Technology Center for Remote Sensing of Ice Sheets +$0.50

This Science and Technology Center (STC) will advance understanding of the contribution of the major polar ice sheets to sea level rise. This increment will assist in the funding of requisite logistics.

USCG Polar Icebreaking -$1.20

There will be a slight decrease anticipated in the cost of USCG polar icebreaker maintenance and operations.

Subtotal, Changes +$48.76

FY 2007 Request, OPP……………………………………………………………………………….. **$438.10**

NSF-WIDE INVESTMENTS

In FY 2007, OPP will support research and education efforts related to broad, Foundation-wide investments in a number of areas, including NSF's multi-disciplinary priority areas and the Administration's interagency R&D priorities.

OPP NSF-wide Investments
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biocomplexity in the Environment	$1.55	$1.53	$0.83	-$0.70	-45.8%
Climate Change Science Program	10.50	10.50	10.50	-	-
Cyberinfrastructure	25.38	26.24	26.24	-	-
Human and Social Dynamics	-	0.20	0.20	-	-
International Polar Year	-	10.00	47.27	37.27	372.7%
Mathematical Sciences	0.20	0.20	0.10	-0.10	-49.5%

Biocomplexity in the Environment will include support for polar genomics consistent with areas of research identified in the National Academy of Sciences/Polar Research Board report *Frontiers in Polar Biology in the Genomic Era,* including enabling aspects such as functional genomics for overall ecosystem understanding.

Climate Change Science Program provides the nation and world with the science-based knowledge to predict change, manage risk, and take advantage of opportunities resulting from climate change and climate variability.

Cyberinfrastructure Support will be provided for the Arctic Systems Sciences (ARCSS) Data Coordination Center that serves as a central point for deposition of data deriving from ARCSS-funded research. Support is also provided for Arctic modeling, distributed field sites, and autonomous flux towers. In the Antarctic, funds support data center/data repositories, 3-D bathymetric data fusion, and environment monitoring, both marine and terrestrial. In addition, support is provided for the engineering, operations and maintenance, and security of information technology systems.

Human and Social Dynamics will support innovative research on the dynamics of human social-cultural systems and individual behavior, as well as human decision-making and risk in the polar regions.

International Polar Year will provide support for the vision established by the National Academy of Sciences/Polar Research Board which includes an "… intense, coordinated campaign of polar observations, research, and analysis that will be multidisciplinary in scope and international in participation….that will benefit society by exploring new frontiers and increasing understanding of the key roles of the polar regions in globally linked systems."

Mathematical Sciences will include support for modeling activities associated with polar research.

QUALITY

OPP maximizes the quality of the R&D it supports through the use of a competitive, merit-based review process. The share of research funds that were allocated to projects that undergo external merit review was approximately 86 percent in FY 2005, the last year for which complete data exist. OMB's definition of competitive, merit-based review does not include contracts, therefore support for the U.S. Antarctic Program support contract, although a competitively bid contract that undergoes a high degree of review, both internal and external, is not considered competitive, merit-based review for this calculation. If included, it would raise the percentage significantly.

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 for proposal review and provide a retrospective assessment of the quality of results of NSF's investments.

OPP also receives advice from the OAC on such issues as: the mission, programs, and goals that can best serve the scientific community; how OPP can promote quality graduate and undergraduate education in the sciences it supports; and priority investment areas in polar research. The OAC meets twice a year. Members represent a cross-section of polar research, with representatives from different disciplines, and include a balanced representation of gender, members of underrepresented groups, and geographic regions.

PERFORMANCE

NSF's FY 2007 budget is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals and the ten investment categories highlighted in the FY 2003-2008 Strategic Plan. These categories were designed as a mechanism to better enable assessment of program performance and to facilitate budget and performance integration.

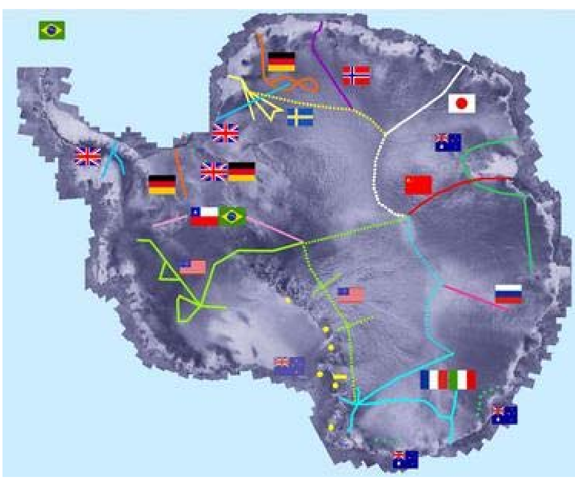
Office of Polar Programs
by Strategic Outcome Goal and Investment Category
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Percent
Ideas					
Fundamental Science and Engineering	$80.62	$67.43	$83.67	$16.24	24.1%
Centers	-	3.95	4.45	0.50	12.7%
Capability Enhancement	-	-	-	-	N/A
	80.62	71.38	88.12	16.74	23.5%
Tools					
Facilities	-	-	0.50	0.50	N/A
Infrastructure and Instrumentation	0.15	-	-	-	N/A
Polar Tools, Facilities and Logistics	261.30	306.95	336.43	29.48	9.6%
Federally-Funded R&D Centers	-	-	-	-	N/A
	261.45	306.95	336.93	29.98	9.8%
People					
Individuals	4.02	6.55	7.08	0.53	8.1%
Instiutions	1.18	1.17	1.68	0.51	43.6%
Collaborations	-	1.00	2.00	1.00	100.0%
	5.21	8.72	10.76	2.04	23.4%
Organizational Excellence	1.25	2.29	2.29	-	-
Total, OPP	$348.53	$389.34	$438.10	$48.76	12.5%

Recent Research Highlights

Ice sheets and climate change: In the air and on the ground: By virtue of its heavy snow accumulation and geologic setting, the West Antarctic Ice Sheet (WAIS) is considered at great risk for catastrophic collapse and melting—an event that could potentially raise the global sea level by about 20 feet. NSF has accordingly joined in a broad international initiative to understand this area. In 2005, for example, scientists from the University of Texas at Austin teamed with researchers from the British Antarctic Survey to conduct an aerogeophysical survey of the ice sheet's key drainage basins. The results are providing a wealth of information for glaciologists, which is especially important because these glaciers currently show signs of accelerated thinning and retreat.

The NSF-supported University of Texas, Austin survey aircraft parked at the remote field camp at Thwaites Glacier which served as one hub of the NSF (US)-British Antarctic Survey (U.K.) collaborative project to study the glaciers. *Credit: Photo by Gonzalo Echeverry*



ITASE traverse routes overlaid on Radarsat imagery. Credit: SCAR ITASE Project Office, Climate Change Institute, University of Maine

NSF is also participating in the International Trans Antarctic Scientific Expedition (ITASE), a 20-nation consortium that is developing a continent-wide, calibrated record of the continent's climate over the last 200-1000 years. ITASE has already completed traverses in the WAIS area, and found that while the peninsula is warming, other areas show temperatures within the average range of the past 200 years. ITASE has an extensive program of public outreach and provides significant opportunities for students to experience multidisciplinary Antarctic research.

NSF's overall WAIS initiative also includes major drilling efforts to recover samples of ancient ice during the upcoming International Polar Year.

Raising awareness about Antarctica through photography: An exhibit titled *Wondrous Cold: An Antarctic Journey* will open May 2006 at the Smithsonian Institution's National Museum of Natural History.

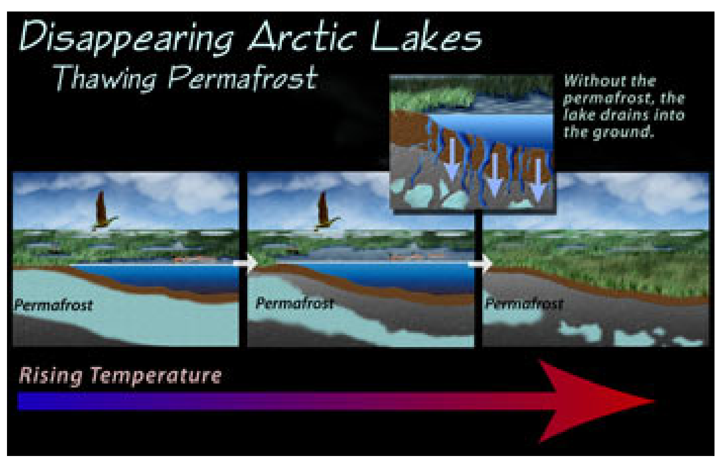
This million-year-old ice core was collected under a research project to understand the Earth's climate record and to infer processes that occur on Mars.

It features the work of photographer Joan Myers, an awardee of NSF's Antarctic Artists and Writers Program, which aims to improve the public's understanding of the Antarctic by giving selected individuals access to the coldest continent.

Through her photographic journal, Myers set out to answer questions that many ponder, such as: Why does Antarctica matter? and Why spend money for research there? Her images of historic huts remind us of hardships faced by explorers, while pictures of modern research stations illustrate progress, as well as the promise of scientific discovery.

Arctic Warming May Be a Factor in Vanishing Lakes: NSF-supported researchers investigating the disappearance of Arctic lakes have identified a prime suspect: climate change. Results of a recent study indicate that rising Arctic temperatures over the past two decades have thawed the ground enough to allow more than 125 lakes to drain into the soil and vanish.

The new finding provides additional evidence that the 20-year-old warming trend documented in the Arctic is physically affecting the landscape. Absence of the lakes could have a devastating effect on the living conditions of native people and Arctic wildlife. Migratory birds depend on these lakes as a summertime habitat and they are critical to the feeding and rearing of young. As temperatures in the region continue to rise, scientists expect this trend to persist and spread northward, resulting in the disappearance of more lakes.

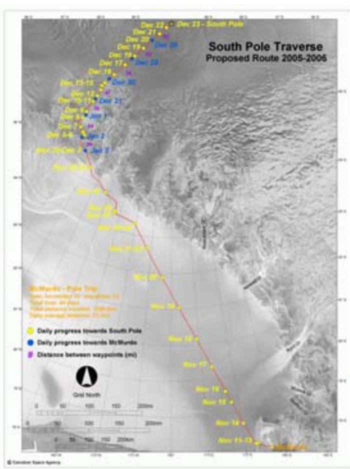


Laurence Smith of the University of California, Los Angeles says rising temperatures have led to the disappearance of 125 Arctic lakes. His study attributes the loss to thawing of the permafrost, a continuous, permanently frozen ground layer that acts as a water barrier beneath lakes. *Credit: Nicolle Rager Fuller, National Science Foundation*

One of the major efforts of the International Polar Year 2007-2008 (IPY) is to assess large-scale environmental change in polar regions. As part of the U.S. IPY effort, NSF's Office of Polar Programs plans to lead an interagency effort titled: "Study of Environmental ARctic CHange (SEARCH)" aimed at documenting and understanding the broad spectrum of Arctic change.

A New System to Resupply the South Pole: An NSF-supported team has found a way around a longstanding problem for research at the South Pole: until now, supplies have only been able to reach the Pole by air when weather permits. On December 22, 2005 the South Pole proof-of-concept traverse arrived at Amundsen-Scott South Pole Station, completing a four-year effort to develop a safe and repeatable overland route to the Pole from McMurdo Station hundreds of miles to the north, where ships and large aircraft drop off equipment and supplies.

The successful traverse makes surface transportation a viable, all-weather alternative to air transportation, and will allow for the movement of items too large to fit into LC-130 Hercules aircraft, the traditional delivery vehicle. When fully implemented, the traverse will also provide a means of potentially resupplying South Pole Station from locations other than McMurdo Station and will support the goals of the International Polar Year by developing critical infrastructure that ensures scientists with long-term access to polar regions.



Traverse route from McMurdo to South Pole. *USAP photo.*

Tractors moving equipment toward the South Pole. *USAP photo.*

Anya Suslova, the 13 year old daughter of ship captain Mikhael Suslov. Anya assisted in sampling and sample processing. With the help of her father, Anya has continued to collect samples since the PARTNERS group left. *Credit: Max Holmes, Woods Hole Oceanographic Institute.*

Arctic River Transport – Teenagers in Science: Researchers and teachers from the U.S. have teamed up with teachers and students in Russia to understand how river water affects the nature of oceans at high latitude. The five-year Pan-Arctic River Transport of Nutrients, Organic Matter, and Suspended Sediments (PARTNERS) project uses river water chemistry as a means to study the origins and transit of continental runoff. Understanding sources and fates of river discharge is important because rivers make an enormous contribution to the freshwater budget of the Arctic Ocean.

Researchers are studying water in the six largest rivers that drain the watershed of the Arctic Ocean: the Yenisey, Lena, Ob, Mackenzie, Yukon, and Kolyma rivers. Analyses of long-term data show an increase in volume over recent decades. If the change in river discharge is linked to global warming, future increases could be large enough to impact circulation of the Atlantic Ocean significantly. In 2004, the PARTNERS group involved a U.S. undergraduate student working in Siberia, as well as two Russian undergraduate students and an elementary school teacher from Vermont. Anya Suslova, a 13-year-old girl living in Zhigansk, volunteered to collect samples throughout the year. This collaboration has grown to include students and teachers in several other towns near river deltas under study.

Other Performance Indicators

The tables below show the number of people benefiting from OPP funding, and trends in award size, duration, number of awards and funding rate.

Number of People Involved in OPP Activities

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Senior Researchers	845	840	920
Other Professionals	645	640	810
Postdoctorates	155	150	110
Graduate Students	395	370	420
Undergraduate Students	270	230	240
Total Number of People	2,310	2,230	2,500

OPP Funding Profile

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Statistics for Competitive Awards:			
Number	284	262	390
Funding Rate	35%	35%	45%
Statistics for Research Grants:			
Number of Research Grants	231	200	340
Funding Rate	30%	30%	40%
Median Annualized Award Size	$122,106	$140,000	$170,000
Average Annualized Award Size	$180,394	$180,000	$200,000
Average Award Duration, in years	2.7	2.7	3.0

U.S. POLAR RESEARCH PROGRAMS $370,580,000

The FY 2007 Budget Request for the U.S. Polar Research Programs subactivity is $370.58 million, an increase of $47.90 million, or 14.8 percent, over the FY 2006 Current Plan of $322.68 million.

U.S. Polar Programs Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Arctic Research Program	$41.04	$35.63	$44.69	$9.06	25.4%
Arctic Research Support and Logistics	35.06	35.20	44.90	9.70	27.6%
Antarctic Research Grants Program	46.19	42.81	52.53	9.72	22.7%
Antarctic Operations and Science Support	146.53	141.76	161.09	19.33	13.6%
Polar Environment, Safety, and Health	0.25	5.13	5.92	0.79	15.4%
STC: Center for Remote Sensing of Ice Sheets	-	3.95	4.45	0.50	12.7%
USCG Polar Icebreaking[1/]	9.20	58.20	57.00	-1.20	-2.1%
Total, Office of Polar Programs	$278.27	$322.68	$370.58	$47.90	14.8%

[1/]Represents all funding provided to USCG. In FY 2005, in addition to payments to USCG, OPP paid $4.13 million to charter the icebreaker *KRASIN* to perform the Antarctic break-in and in FY 2006, in addition to payments to USCG, OPP estimates it will cost $9 million to charter the icebreaker *KRASIN* to perform the Antarctic break-in.

<u>About U.S. Polar Research Programs:</u>

The U.S. Polar Research Programs subactivity supports both Arctic and Antarctic 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 Arctic 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.

Antarctic support includes funding for NSF-supported researchers as well as meeting NSF responsibilities as manager of the entire federal Antarctic program, including special requirements for operations and science support. The program provides grants to fund scientific research related to Antarctica and to the Southern Ocean. 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.

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 these remote locations and fuel to the South Pole. See the MREFC chapter for further information on these projects.

In general, approximately 45 percent of U.S. Polar Research Programs funds are available for new awards and activities. The remaining 55 percent funds commitments to awards made in previous years.

U.S. Polar Research Programs has two major modes of support: research and education grants, and polar facilities and logistics.

- OPP research and education grants range widely in scope and include individual-investigator awards for field research in the Arctic and Antarctica or the investigator's home institution; large collaborative awards with numerous investigators and institutions; awards for projects with international partners; awards for provision of science support in the polar regions; and agreements with other government agencies for logistic support in the polar regions. In FY 2005, OPP received approximately 685 competitive proposals and funded 270, for a funding rate of 39 percent.

- OPP is also responsible for operating and maintaining the three U.S. stations in Antarctica as well as supporting research in the Arctic, making research possible in these remote, but scientifically unique regions. In FY 2006, NSF assumed the responsibility from the U.S. Coast Guard for funding the costs of icebreakers that support scientific research in polar regions.

U.S. ANTARCTIC LOGISTICAL SUPPORT ACTIVITIES $67,520,000

The FY 2007 Budget Request for U.S. Antarctic Logistical Support Activities is $67.52 million, an increase of $860,000, or 1.3 percent, over the FY 2006 Current Plan.

U. S. Antarctic Logistical Support Activities Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change from FY 2006 Amount	Change from FY 2006 Percent
U.S. Antarctic Logistical Support Activities	$70.26	$66.66	$67.52	$0.86	1.3%

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 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.
- Fuel purchased from the Defense Logistics Agency.
- Reimbursement for use of Department of Defense satellites for communications.

INTEGRATIVE ACTIVITIES $131,370,000

The FY 2007 Budget Request for Integrative Activities (IA) is $131.37 million, a decrease of $5.75 million, or 4.2 percent, below the FY 2006 Current Plan of $137.12 million.

Integrative Activities Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Integrative Activities	$130.92	$137.12	$131.37	-$5.75	-4.2%

RELEVANCE

Integrative Activities 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. It also funds a number of integrative research and education centers and programs that support and enhance NSF research investments in discovery and workforce development.

Funds requested and appropriated to IA are managed by a variety of organizations within NSF, which provides the flexibility to broaden support for emerging cross-disciplinary research programs and activities. For example, the Science and Technology Centers program currently supports 17 centers that are managed cooperatively by six NSF directorates/offices and the Office of Integrative Activities.

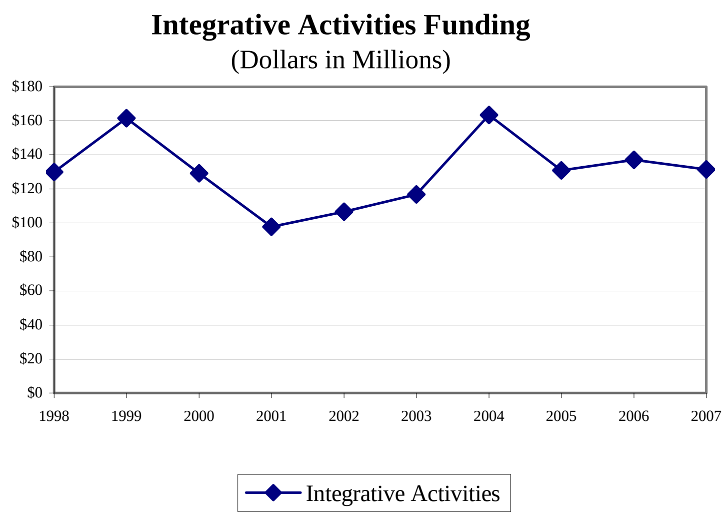
Integrative Activities Funding by Program

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Science of Learning Centers	$19.83	$22.71	$27.00	$4.29	18.9%
Science and Technology Centers[1]	7.31	12.74	0.90	-11.84	-92.9%
Major Research Instrumentation	89.26	88.39	90.00	1.61	1.8%
Partnerships for Innovation	9.92	9.00	9.19	0.19	2.1%
Science and Technology Policy Institute/RaDiUS	4.03	4.28	4.28	-	-
EPSCoR, Katrina-Related Activity	0.57	-	-	-	N/A
Total, Integrative Activities	$130.92	$137.12	$131.37	-$5.75	-4.2%

Totals may not add due to rounding.

[1/]The decrease for Science and Technology Centers funding reflects awards from the FY 2005 competition. The funds are shown in Integrative Activities line in the FY 2006 Current Plan, and are transferred to the cognizant directorate/office in FY 2007.



Summary of Major Changes *(Dollars in Millions)*

FY 2006 Current Plan $137.12

Advancing the Frontier

Science of Learning Centers (SLC) +$4.29

The $4.29 million increase brings FY 2007 funding for the SLCs to $27.0 million. NSF's investment builds on the Foundation's support for multidisciplinary research that advances fundamental knowledge about the science of learning. SLCs are built around a unifying research focus and incorporate a diverse, multidisciplinary environment involving appropriate partnerships with academia, industry, international partners, all levels of education, and other public and private entities.

In FY 2007, NSF continues the fourth of five initial years of support for four Centers awarded in the program's first competition. The increased funding will support a diverse portfolio of research projects, providing leadership across a broad range of science and engineering approaches to the science of learning research.

Science and Technology Centers (STC) -$11.84

The FY 2007 Request reflects the transfer of $11.84 million for four Science and Technology Centers initiated in FY 2006 from within IA to the appropriate managing subactivities in the Research and Related Activities account (BIO, GEO (2), MPS). At the FY 2007 Request level, the STC program will support 17 centers that are based in NSF directorates and offices and managed cooperatively with the Office of Integrative Activities. The remaining $900,000 provides ongoing administrative support for activities such as annual site visits, contractor support costs, meetings, and workshops involving the 17 fully operational STCs.

STCs are university-based research efforts that foster partnerships and collaborative cultures among researchers and educators at all levels of academia, industry, government laboratories, and other public and private organizations. They offer a value-added approach and provide opportunities to explore 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.

<u>Infrastructure and Instrumentation</u>

Major Research Instrumentation (MRI) +$1.61

An increase of $1.61 million brings FY 2007 funding to $90.0 million. Funding supports a diverse portfolio of projects that emphasizes state-of-the-art instrumentation, access and training to support modern research approaches, cross-disciplinary research, public/private partnerships, and support for minority-serving institutions. MRI funding provides for the acquisition and development of major state-of-the-art research instrumentation that is too costly to be supported through regular NSF programs. By improving research training and integrated research and education activities at U.S. institutions for scientists, engineers, graduate, and undergraduate students, MRI projects strengthen science education. Cross-departmental units funded by MRI enable academic departments to create well-equipped learning environments that integrate research with education. MRI also promotes partnerships between academic researchers and private sector instrument developers. Finally, the MRI program directs approximately $20.0 million 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.

In the FY 2005 MRI competition, NSF received 785 proposals and funded 255 (a funding rate of 32 percent) for a total of $89.26 million. Included within this group were 79 proposals from minority-serving institutions and 281 proposals from non-Ph.D. granting institutions (includes some minority-serving institutions). Minority-serving institutions received 26 awards totaling $9.20 million. Non-Ph.D. granting institutions received 109 awards totaling $25.80 million. Funding provided for FY 2006 (Current Plan) and requested for FY 2007 will enable NSF to make approximately 260 awards.

Partnerships for Innovation (PFI) +$0.19

An increase of $190,000 brings FY 2007 funding to $9.19 million. Funding for the Partnerships for Innovation (PFI) supports partnership grants that seek to (1) stimulate the transformation of knowledge created by the national research and education enterprise into innovations that increase competitiveness, 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. Awards are for up to $600,000 for a maximum of three years, and more than 90 percent involve academic institutions that do not normally receive a large amount of funding from NSF. The budget level supports 10 to 15 PFI awards.

STPI/RaDiUS

NSF's FY 2007 budget provides $2.94 million for the Science and Technology Policy Institute (STPI) and $1.34 million for the Research and Development in the United States

(RaDiUS) database. These levels are unchanged from FY 2006. STPI is a Federally-Funded Research and Development Center established by Congress in 1992 to support the complex task of analyzing and contributing to the development of 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 options for achieving those objectives. In addition, the Institute supports OSTP by assembling and analyzing information regarding significant science and technology developments and trends. Since 2003, the Institute for Defense Analyses has operated STPI. RaDiUS is a database that was developed and is maintained by the RAND Corporation to collect and maintain information on federal investment in research and development.

Subtotal, Changes .-$5.75

FY 2007 Request, IA....…………………….………..…………………………………………. $131.37

QUALITY

NSF uses various internal and external mechanisms to ensure the quality and relevance of existing and proposed programs and to help identify new and emerging opportunities that support agency-specific goals. These mechanisms include merit-based review of proposals, Committees of Visitors, advisory committees and other expert panels, National Academies and other reports, workshops, and long-range planning documents.

NSF maximizes the quality of the R&D it supports through the use of a competitive, merit-based process. To ensure the highest quality in processing and recommending proposals for awards, NSF convenes Committees of Visitors, composed of qualified external evaluators, to review each program. 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. Other programs conduct annual reviews and will undergo a review and assessment of program outcomes in FY 2007.

The Science and Technology Centers (STC): Integrative Partnerships program maintains a variety of ongoing practices that ensure quality during the 10-year tenure of each project. These practices include strategic planning, annual review by an external team of expert site visitors, fourth-year in-depth, competitive review of renewal proposals, training of NSF technical coordinators, and shared governance between research directorates and the Office of Integrative Activities. Additionally, each Center is required to submit an annual report to NSF, participate in annual workshops developed for Center directors and the center education network, provide ethics training, provide specialized communications equipment, and maintain and convene annually a conflict-free external advisory board that provides guidance, advice, and oversight.

The MRI program is a Foundation-wide cross-cutting activity. MRI program proposal actions are reviewed on a three-year basis by COVs in the directorates and divisions that recommend and award grants. In addition to these directorate and division reviews, the program conducts an overall evaluation. In FY 2005, the MRI program convened a COV during which the external evaluators examined overall program management and processes, proposal actions, and the results of NSF investments during five fiscal years: 2000 through 2004.

PERFORMANCE

NSF's FY 2007 budget is also aligned to reflect funding levels associated with the Foundation's four strategic outcome goals and the ten investment categories highlighted in the FY 2003-2008 Strategic Plan. These categories were designed as a mechanism to better enable assessment of program performance and to facilitate budget and performance integration.

Integrative Activities
By Strategic Outcome Goal and Investment Category
(Dollars in Millions)

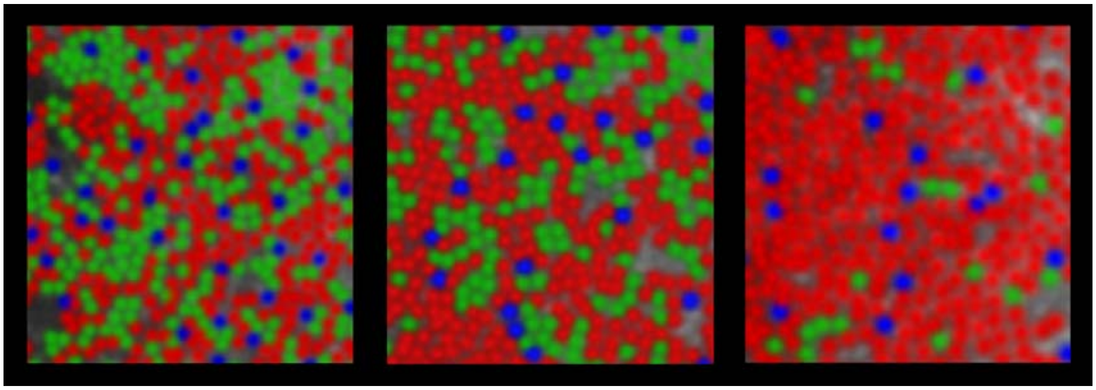
	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Ideas					
Fundamental Science and Engineering	-	-	-	-	0.0%
Centers Programs	$27.14	$35.45	$27.90	-$7.55	-21.3%
Capability Enhancement	0.57	-	-	-	N/A
	27.71	35.45	27.90	-7.55	-21.3%
Tools					
Facilities	-	-	-	-	N/A
Infrastructure and Instrumentation	89.26	88.39	90.00	1.61	1.8%
Polar Tools, Facilities and Logistics	-	-	-	-	N/A
Federally-Funded R&D Centers	4.03	4.28	4.28	-	0.0%
	93.29	92.67	94.28	1.61	1.7%
People					
Individuals	-	-	-	-	N/A
Institutions	-	-	-	-	N/A
Collaborations	9.92	9.00	9.19	0.19	2.1%
	9.92	9.00	9.19	0.19	2.1%
Organizational Excellence	-	-	-	-	N/A
Total, IA	$130.92	$137.12	$131.37	-$5.75	-4.2%

Totals may not add due to rounding.

Recent Research Highlight

► **Astronomical Adaptive Optics Applied to the eye reveals remarkable features of human color vision and perception:** Heidi Hofer and colleagues at the University of Rochester have successfully imaged the cone cells distributed throughout the retina in eight living human eyes. The figure below shows three of these distributions, which have been artificially colored to indicate the arrangement and relative numbers of the three kinds of cones that are responsible for color vision.

The researchers obtained the images using a high-resolution camera equipped with adaptive optics. Adaptive optics was originally developed to correct for the aberrations generated by atmospheric turbulence in ground-based telescopes, but the Rochester team demonstrated in 1997 that this technology could be used also to correct the aberrations that are peculiar to each person's cornea and lens. Their technique allowed the first routine, noninvasive microscopic high-resolution images of the retina of the human eye.



Credit: University of Rochester

The NSF Science and Technology Center for Adaptive Optics brings astronomers and vision scientists together to improve the technology, which shows promise for helping us understand and perhaps someday better treat retinal diseases such as retinal degenerations, diabetic retinopathy and glaucoma. (MPS)

ARCTIC RESEARCH COMMISSION $1,450,000

The FY 2007 Budget Request for the Artic Research Commission (ARC) is $1.45 million, an increase of $280,000, or 23.5 percent, over the FY 2006 Current Plan of $1.17 million.

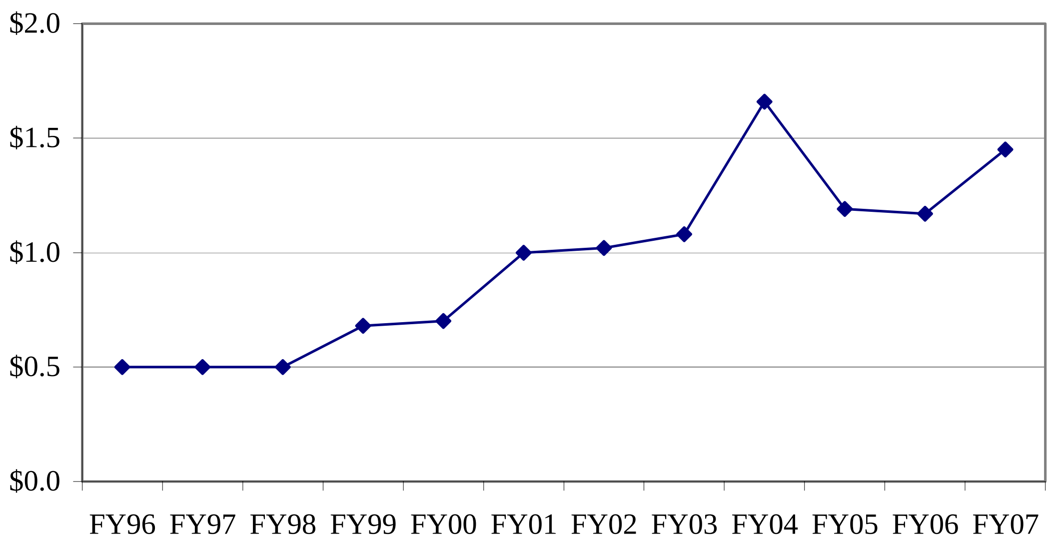
Arctic Research Commission Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Arctic Research Commission	$1.19	$1.17	$1.45	$0.28	23.5%

ARC is an independent federal agency, historically funded through NSF's appropriations, specifically within the Office of Polar Programs (OPP). The FY 2007 Budget Request proposes to provide a separate budget line for ARC within the Research and Related Activities (R&RA) appropriations account. This proposal is based on a number of factors, the most significant being the lack of explicit NSF authority to oversee the Commission's activities or to determine its funding level. In addition, several audits of ARC have recommended that the ARC budget be, at a minimum, a separate budget line in the R&RA account. Auditors were concerned as are the Commissioners that the Commission was not dealt with as an independent agency. The Commissioners also seek to dispel the misperception that the Commission draws funds away from research.

For the FY 2007 Budget Request, the OPP budget has been reduced by the amount of ARC funding for the years represented in the budget – FY 2005 through FY 2007.

ARC Subactivity Funding
(Dollars in Millions)



The United States Arctic Research Commission was established by the Arctic Research and Policy Act of 1984, (as amended, P. L. 101-609), to establish the national policy, priorities, and goals necessary to construct a federal program plan for basic and applied scientific research with respect to the Arctic, including natural resources and materials, physical, biological and health sciences, and social and behavioral sciences. This request provides funds to promote Arctic research, to recommend Arctic research policy, and to communicate research and policy recommendations to the President and the Congress, as well as supporting close collaboration with the National Science Foundation as the lead agency responsible for implementing Arctic research policy and supporting cooperation and collaboration throughout the Federal Government. In addition, ARC gives guidance to the Interagency Arctic Research Policy Committee (IARPC) to develop national Arctic research projects and a five-year plan to implement those projects. ARC also supports interaction with Arctic residents, international Arctic research programs and organizations and local institutions including regional governments in order to obtain the broadest possible view of Arctic research needs.

The Arctic Research Commission is requesting an increase of $280,000 above the FY 2006 Current Plan. The added funding will go to salaries – specifically increased funding for Commissioners salaries and to hire one additional FTE. Currently, there are 3 FTE funded, with a total authorized of 7 FTE. This funding will allow ARC to add one FTE, planned to be a GS-12 publication specialist in Anchorage, AK, to aid in the production of 2 additional reports.

EDUCATION AND HUMAN RESOURCES $816,220,000

The FY 2007 Budget Request for the Directorate for Education and Human Resources (EHR) is $816.22 million, an increase of $19.53 million, or 2.5 percent, over the FY 2006 Current Plan of $796.69 million.

Education and Human Resources Funding
(Dollars in Millions)

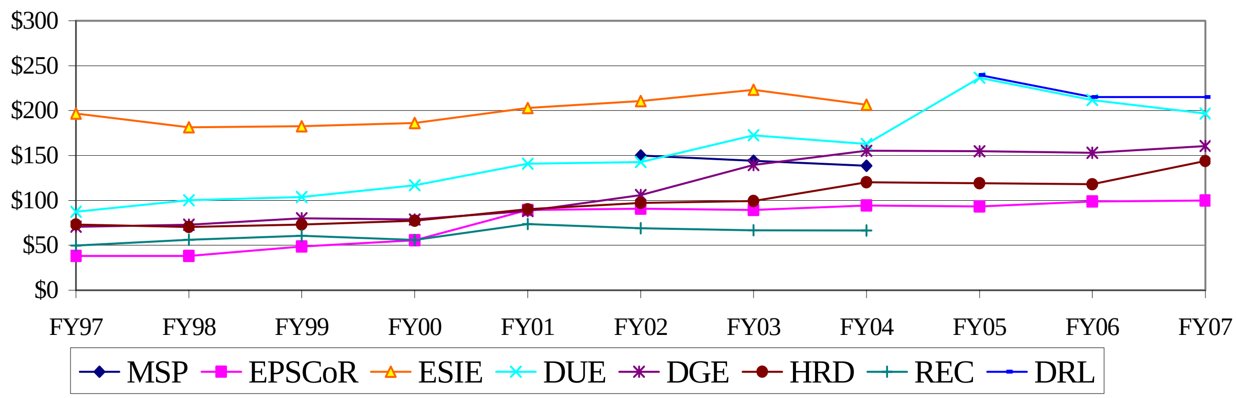
	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Experimental Program to Stimulate Competitive Research (EPSCoR)	$93.35	$98.72	$100.00	$1.28	1.3%
Research on Learning in Formal and Informal Settings (DRL)	238.76	215.16	215.00	-0.16	-0.1%
Undergraduate Education (DUE) [1]	237.52	211.71	196.80	-14.91	-7.0%
Graduate Education (DGE)	154.75	153.02	160.57	7.55	4.9%
Human Resource Development (HRD) [1]	119.16	118.08	143.85	25.77	21.8%
Total, EHR [2]	$843.54	$796.69	$816.22	$19.53	2.5%

Totals may not add due to rounding.

[1] FY 2005 Actual and FY 2006 Current Plan reflect proposed FY 2007 structure of programs. See text for additional detail.
[2] Excludes $25.95 million in obligations in FY 2005, and an estimated $100.0 million in FY 2006 and FY 2007 from H-1B Nonimmigrant Petitioner Fees.

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, EHR promotes the development of a diverse and well-prepared workforce of scientists, technicians, engineers, mathematicians and educators and a well-informed citizenry who have access to the ideas and tools of science and engineering. EHR supports education, research, and infrastructure development in all S&E 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 and to build the science, technology, engineering and mathematics (STEM) workforce of the 21st century.

EHR Subactivity Funding
(Dollars in Millions)



Appropriation Language

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, authorized travel, and rental of conference rooms in the District of Columbia, ~~807,000,000~~*$816,220,000*, to remain available until September 30, ~~2007: *Provided*, That to the extent that the amount of this appropriation is less than the total amount authorized to be appropriated for included program activities, all amounts, including floors and ceilings, specified in the authorizing Act for those program activities or their subactivities shall be reduced proportionally~~*2008*. *(Science Appropriations Act, 2006.)*

Education and Human Resources
Budgetary Resources Summary
(Dollars in Millions)

	Enacted / Request	Rescission	Carryover / Recoveries	Lapsed	Total Resources	Obligations Incurred / Estimated
FY 2005 Actual	848.21	-6.79	2.70	-0.18	843.94	843.54
FY 2006 Current Plan	807.00	-10.31	0.40	-	797.09	797.09
FY 2007 Request	816.22	-	-	-	816.22	816.22
$ Change from FY 2006	9.22				19.13	
% Change from FY 2006	1%				2%	

Totals may not add due to rounding.

Explanation of Carryover

Within the EHR appropriation $401,829 was carried forward into FY 2006. This includes $298,210 for efforts related to Hurricane Katrina, and $100,000 for the Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring program (PAESMEM).

RELEVANCE

NSF's Directorate for Education and Human Resources is the principal source of federal support for strengthening S&E education. EHR programs support technological innovation to enhance economic competitiveness and new job growth. EHR addresses the workforce needs of the Nation and ensures a scientifically literate population and a robust supply of qualified experts.

Critical challenges face the Nation's S&E educational system. How can we ensure that adequate numbers of K-12 teachers are sufficiently knowledgeable in science or mathematics? How do we motivate high school students to enroll in physics or chemistry classes, or to complete enough mathematics to be ready to study science or engineering at the college level? How do we make it so the individuals who obtain baccalaureate or graduate degrees in S&E fields fully reflect the Nation's diverse population?

EHR activities strengthen U.S. education at all levels and help ensure continued U.S. economic and research preeminence. These activities 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."

The EHR portfolio focuses on four goals:

- Prepare the next generation of S&E professionals and attract and retain more Americans in S&E careers.
- Develop a robust research community that can conduct rigorous research and evaluation that will support excellence in S&E education and will integrate research and education.
- Broaden participation (individuals, geographic regions, types of institutions, S&E disciplines) and close achievement gaps in all S&E fields.
- Increase the technological, scientific, and quantitative literacy of all Americans so that they can exercise responsible citizenship and live productive lives in an increasingly technological society.

For each of these goals, key programmatic strategies have been developed. The FY 2007 Budget Request provides support for a broad range of educational activities:

- K-12 programs focus on funding research on the development of effective S&E instructional materials as well as teacher preparation and professional development. In addition, they support research and development on effective materials that promote scientific and technological literacy for learners of all ages.
- Undergraduate programs focus on: developing courses, curricula and laboratory experiences for two- and four-year colleges and universities, expanding the Nation's S&E talent, addressing federal workforce needs for cybersecurity specialists, fostering S&E education capacity at minority-serving institutions, and promoting the participation and advancement of women and minority students in the S&E enterprise.
- Graduate programs provide support to attract and prepare U.S. students for S&E careers.
- Evaluation and research on education are emphasized throughout the EHR portfolio to inform improvements in 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.
- Math and Science Partnerships bridge K-12 and higher education through a focus on the engagement of disciplinary faculty in K-12 activities.

Summary of Major Changes by Division *(Dollars in Millions)*

FY 2006 Current Plan, EHR…………………………………………………………...........…$796.69

Experimental Program to Stimulate Competitive Research (EPSCoR) +$1.28

EPSCoR will continue its Research Infrastructure Improvement (RII) component and will also fund two Strength-Based Research Collaboratives (SBRC) in FY 2007. SBRC funding will increase by $2.0 million over the FY 2006 Current Plan (the EPSCoR increase of $1.28 million, along with $720,000 of reallocated funds within EPSCoR.)

Research on Learning in Formal and Informal Settings (DRL) -$0.16

DRL will be created in FY 2006 through the merger of the former Elementary, Secondary and Informal Education (ESIE) division and the Research, Evaluation and Communication (REC) division.

Undergraduate Education (DUE) -$14.91

Support for the Math and Science Partnership (MSP) program, which will become part of DUE in FY 2006, decreases by $17.18 million. Funding will be continued for all existing MSP projects including new awards for Institute Partnerships made in FY 2006; and for data collection, evaluation, and dissemination. Funding for the Course, Curriculum, and Laboratory Improvement (CCLI) program decreases by $2.63 million, as the program is transformed and introduces phases to help prioritize efforts. Support increases for the other curriculum, laboratory and instructional development programs – Robert Noyce Scholarship program, STEM Talent Expansion Program (STEP), and the National STEM Education Digital Library (NSDL). Support increases for the workforce development programs – Advanced Technological Education (ATE), Federal Cyber Service: Scholarship for Service (SfS), and Excellence Awards in Science & Engineering (EASE).

Graduate Education (DGE) +$7.55

Funding will increase for the three flagship graduate programs. In comparison to the FY 2006 Current Plan, this increase will support an additional 25 U.S. doctoral students in IGERT; an additional 65 graduate students in GRF; and an additional 50 doctoral students in the GK-12 program.

Human Resource Development (HRD) +$25.77

Support increases significantly for HRD's programs, all of which emphasize broadening participation in the science and engineering workforce. Many HRD programs are focal points for linking activities in NSF's EHR Directorate with NSF's R&RA directorates to strengthen collaborations that integrate research and education. The demand for these programs exceeds NSF's recent capacity. Support for these highly successful and respected programs will aid in addressing the S&E workforce needs of the Nation to ensure a scientifically literate population and a robust supply of qualified experts across all fields.

Subtotal, Changes +$19.53

FY 2007 Request, EHR ……………………………………………………………………........$816.22

Summary of Major Changes in Directorate-Wide Investments *(Dollars in Millions)*

FY 2006 Current Plan, EHR……………….…………………………………………...........…$796.69

Advancing the Frontier -$6.87

Support for the Research and Evaluation on Education in Science and Engineering (REESE) program, which will be created in FY 2006 through the realignment of the portfolio of the former REC division, will decrease by $6.87 million. Support is reallocated to the Discovery Research K-12 program. REESE will support cutting-edge, innovative, and experimental advances in learning and education across the S&E disciplines as well as research on evaluation and modeling activities that will enable researchers and educators to understand what works in educational innovations and, most importantly, why it works, in what contexts, and for whom. REESE will support activities most likely to lead to long-term improvements in the Nation's S&E educational enterprise.

Broadening Participation in the S&E Enterprise +$32.48

EHR will significantly increase funding for programs supporting NSF's efforts in Broadening Participation in the S&E Enterprise:

- Robert Noyce Scholarship program (Noyce) increases by $1.0 million to $9.77 million.
- Advanced Technological Education (ATE) increases by $990,000 to $45.92 million.
- Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) increases by $4.53 million to $29.71 million.
- Informal Science Education (ISE) increases by $2.94 million to $65.64 million.
- The Louis Stokes Alliances for Minority Participation (LSAMP) program increases by $4.66 million to $39.66 million and support for Alliances for Graduate Education and the Professoriate (AGEP) increases by $4.45 million to $18.95 million.
- The Program for Gender Equity (PGE) increases by $1.28 million to $10.96 million.
- Research in Disabilities Education (RDE) increases by $660,000 to $5.77 million.
- The Tribal Colleges and Universities Program (TCUP) increases by $3.15 million to $12.42 million.
- Centers of Research Excellence in Science and Technology (CREST) increases by $7.04 million to $24.94 million. Two to four new CREST Centers will be initiated.
- Experimental Program to Stimulate Competitive Research (EPSCoR) increases by $1.28 million to $99.65 million.
- Science, Technology, Engineering and Mathematics Talent Expansion Program (STEP) increases by $500,000 to $26.07 million.

Facilities and Infrastructure, including Cyberinfrastructure +$0.50

Support for the National STEM Education Digital Library (NSDL) will increase.

Bolstering NSF's K-12 Education Portfolio

Discovery Research K-12 (DR-K12) +$10.71

DR-K12 will be created in FY 2007 through the merger of EHR's three formal K-12 education programs – Teacher Professional Continuum (TPC), Instructional Materials Development (IMD) and Centers for Learning and Teaching (CLT). Although the DR-K12 program will maintain the pre-existing focus on students, teachers, and schools, it will offer researchers and educators increased flexibility to work either in topical areas or across broad new domains to seek answers to the grand challenges facing K-12 education. DR-K12 will focus on applied research and development, building on the cutting-edge, experimental research supported by REESE, and handing off innovations to states and districts for large-scale implementation.

Math and Science Partnership Program. -$17.18

Support will be continued for existing projects. No new awards will be made.

Other

- GK-12, GRF and IGERT. +$7.55
- The new Excellence Awards in S&E (EASE) program combines the Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM), Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST) and Distinguished Teaching Scholars (DTS) programs to provide more effective administration of these activities and improve intra-agency cooperation. +$2.41
- Scholarships for Service / Cybercorps. +$0.50

- Academies for Young Scientists is a pilot program to be initiated in FY 2006. Since this activity is a demonstration project in FY 2006, no funds are requested in FY 2007. -$6.94
- Course, Curriculum and Laboratory Improvement. -$2.63
- Final funding in FY 2006 for Higher Education Centers for Learning and Teaching. -$1.00

Subtotal, Changes +$19.53

FY 2007 Request, EHR ………………………………………………………………………........$816.22

NSF-WIDE INVESTMENTS

In FY 2007, the EHR Directorate will support research and education efforts related to broad, Foundation-wide investments in a number of areas, including NSF's multidisciplinary priority areas and the Administration's interagency R&D priorities.

EHR NSF-wide Investments

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Cyberinfrastructure	$20.27	$15.02	$15.52	$0.50	3.3%
International Polar Year	-	-	2.00	2.00	N/A
Mathematical Sciences	2.85	2.20	1.09	-1.11	-50.5%
National Nanotechnology Initiative	3.16	2.90	3.00	0.10	3.4%
Networking and Information Technology R&D	4.06	3.75	3.90	0.15	4.0%

EHR's **cyberinfrastructure** support totals $15.52 million, an increase of $500,000 over the FY 2006 Current Plan, and funds the National STEM Education Digital Library, an online network of learning environments and resources for STEM education at all levels in both formal and informal settings.

EHR will provide $2.0 million in FY 2007 for activities related to the **International Polar Year**. EHR will support IPY's education and outreach goals by engaging the public through projects such as museum exhibits, large format films and television and radio documentaries. In addition, EHR will work to develop field experiences in polar research for college students as well as K-12 educators and help teachers bring polar research to their classrooms.

FY 2007 support for the **Mathematical Sciences** priority area totals $1.09 million, a decrease of $1.11 million from the FY 2006 Current Plan, as this priority area transitions into the core. It will provide continuing support for mathematical sciences education activities.

FY 2007 **National Nanotechnology Initiative** (NNI) support totals $3.0 million, an increase of $100,000 over the FY 2006 Current Plan. It will provide continuing support for nanoscience education activities.

FY 2007 support for **Networking and Information Technology R&D** (NITRD) totals $3.90 million, an increase of $150,000 over the FY 2006 Current Plan. It will provide continuing support for information technology education activities.

Additional detail may be found in the NSF-wide Investment chapter.

QUALITY

EHR maximizes the quality of the research and education it supports through the use of a competitive, merit-based review process. 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 Education and Human Resources Advisory Committee (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 S&E; and priority investment areas in S&E education research. The EHRAC meets twice a year and members represent a cross section of S&E disciplines; a cross section of institutions including industry; broad geographic representation; and balanced representation of women and underrepresented minorities.

PERFORMANCE

The table below shows the strategic planning and evaluation framework for activities funded through the Education and Human Resources appropriation. This framework was established in the NSF Strategic Plan for FY 2003-2008. The Advisory Committee for GPRA Performance Assessment assesses NSF's strategic outcome goals annually. The investment categories are assessed using the Program Assessment Rating Tool (PART). Additional information on these activities is available in the Performance Information section of this document.

Directorate for Education and Human Resources
By Strategic Outcome Goal and Investment Category
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Ideas					
Fundamental Science and Engineering	$59.96	$48.06	$41.19	-$6.87	-14.3%
Centers Programs	-	-	-	-	N/A
Capability Enhancement	108.68	116.27	124.59	8.32	7.2%
	168.64	164.33	165.78	1.45	0.9%
Tools					
Facilities	-	-	-	-	N/A
Infrastructure and Instrumentation	17.77	15.02	15.52	0.50	3.3%
Polar Tools. Facilities and Logistics	-	-	-	-	N/A
Federally Funded R&D Centers	-	-	-	-	N/A
	17.77	15.02	15.52	0.50	3.3%
People					
Individuals	175.07	170.92	179.97	9.05	5.3%
Institutions	110.94	107.43	105.29	-2.14	-2.0%
Collaborations	363.41	328.99	339.66	10.67	3.2%
	649.42	607.34	624.92	17.58	2.9%
Organizational Excellence	7.72	10.00	10.00	-	-
Total, EHR	$843.54	$796.69	$816.22	$19.53	2.5%

Totals may not add due to rounding.

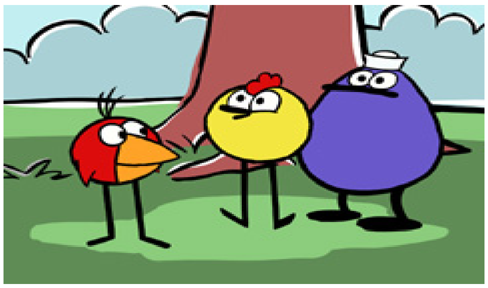
Recent Research Highlights

NSDL Logo

► **Learning Resources Without Walls: Professional Development Workshops for Katrina-Affected Teachers:** In December 2005, the National Science Digital Library (NSDL), in partnership with the Digital Library for Earth System Education (DLESE) offered free online professional development workshops to K-12 science and math teachers in hurricane-impacted schools, as well as to those teaching hurricane-displaced students. The idea was that online resources, such as those offered by NSDL and DLESE, could help offset the scarcity of textbooks and other basic teaching materials in affected communities. The workshops provided practical ideas for finding and using digital library resources, with a particular emphasis on strategies that are easy to implement in storm-stressed classrooms and in distance learning courses being offered to displaced students. Through the use of web and phone conferencing, Susan Van Gundy and Robert Payo of NSDL and Lynne Davis of DLESE provided an overview of the nature of digital libraries and strategies for implementing these resources in classroom teaching and curriculum development. (DUE)

► **Cyber-War Exercises Add Value to Undergraduate Computer Security Curricula:** Building on an earlier NSF-supported project at the Indiana University of Pennsylvania, educators at the University of Wisconsin, Eau Claire, have developed the Computational Laboratory for Information and Computer Security, or CLICS. Funded by NSF's Course, Curriculum, and Laboratory Improvement program, CLICS is a two day "cyber-war exercise" that gives undergraduate students hands-on experience with the issues, strategies, and tools involved in computer security and information assurance. The Cyber-war exercises involve students in real-world, team-based efforts to harden their systems, detect intrusions and respond in real time – without threatening the wider campus network. The exercises are not only fun, but turn the theory of computer security into real-world practice. (DUE)

Students engaged in the CLICS cyber war exercise: attack... and... defend. *Credit: Andrew Phillips*



Friends Chirp, Peep, and Quack.
Credit: WGBH

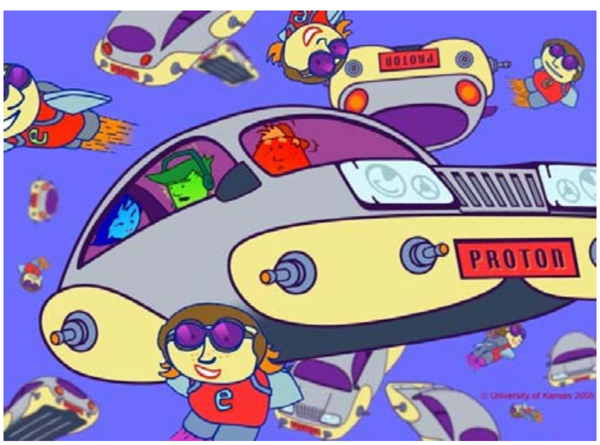
► **"Peep and the Big Wide World" Engages Preschool Children in Science Exploration:** Peep and the Big Wide World (PEEP), a daily, half-hour television series with accompanying web and outreach activities for 3- to 5-year-olds, gives wings to the innovative idea of teaching science to preschoolers. Airing on TLC and the Discovery Kids Channel, the TV series is tied for the top-rated program for children 2-5 in the weekday morning time block. Less than a year into its broadcast, moreover, PEEP is meeting its goals: the Goodman Research Group has found that children exposed to PEEP act in ways that are significantly more scientifically grounded than those who are not. When presented with materials to manipulate and explore, for example, they are more likely by a margin of 71% to 22% to initiate asking a question to be explored. Children exposed to PEEP are also more likely to use problem-solving strategies (76% versus 34%), and more likely to solve the problems that they initiate (74% versus 31%). The series is also reaching parents, providing them with information on how to extend their children's science learning in everyday situations. And PEEP is impacting the field of informal science education, as well, by giving preschool educators resources and training in how to nurture young children's science learning. PEEP is achieving this impact in part through its community of collaborators. Partners include educational organizations (e.g., 4-H, the National Education Association, Parents as Teachers), libraries (American Library Association), museums (via the Boston Children's Museum), and promotional media outlets. This network helps promote the series' educational goals across different platforms while maximizing resources, extending impact, and reaching underserved audiences. (DRL)

► **North Carolina LSAMP Project produces 900 new STEM graduates a year:** The state of North Carolina has experienced an increase in new STEM graduates as a result of the North Carolina LSAMP project. Led by North Carolina A&T State University, the NC-LSAMP is a partnership of eight North Carolina colleges and universities, and has received funding since 1992. The project is charged with increasing the quantity and quality of underrepresented minority students receiving bachelor's degrees in STEM disciplines. In one year, 2003 to 2004, NC-LSAMP reported an increase in students enrolled in STEM majors of 7 percent (5858 to 6259), and graduated 891 students in STEM fields. In addition, the newly instituted "Bridge to the Doctorate" initiative is in high gear supporting over two dozen graduate students in a broad range of science and engineering disciplines. (HRD)

► **IGERT Students Participate in Local, State and International Efforts on Sustainability in Alaska:** In an effort to translate scientific discovery into policy and action at local, state, and international levels, IGERT students at the University of Alaska, Fairbanks, are assessing the sustainability of high-latitude regions, and working to discover how to reduce the vulnerability of these regions to both ecological and social change. Two of the students have participated in an international effort, sponsored by the Swedish Royal Academy of Agriculture and Forestry, to synthesize current knowledge on sustainability; the papers that resulted have been published in an international journal (Ambio) geared to policy makers. Another student contributed to the polar chapter of the UNESCO-sponsored Millennium Assessment, which is investigating the impacts of global change on human well-being. Two more students participated in the synthesis of research on Sustainability of Arctic Communities. Three others played leading roles in developing state resource-management policies that enhance sustainability. (These included a revision of the coastal-zone management plan; development of state legislation to enhance carbon sequestration rather than timber harvest; and an assessment of the success of sustainable management of the Tongass National Forest for a report to the U.S. Congress.) Finally, four students worked with Native village councils or with the Alaska Native Science Commission to develop plans to assess changes in the subsistence resource base for Native Alaskans. (DGE)

IGERT student La'ona DeWilde is participating in the first comprehensive analysis of human impacts on fire regime resulting from changes in ignition and suppression to provide a basis for modifying fire management strategies. *Credit: Terry Chapin*

► **Quarked™: An Interactive Multimedia Education Project:** The Quarked™ project is seeking to create an entertaining multimedia experience about quarks aimed at children ages 7-12, but accessible to all ages including adults. The educational goals of the project are to introduce quarks and the people who work with them into the common language of kids; investigate how young people are introduced to and grasp the scientific world of the unseen and abstract; and to demystify subatomic physics, while changing the perception that science is difficult and inaccessible. Already under development are a half-hour animated TV series, an interactive web site (www.quarked.org), museum programs, and educational outreach activities. The television show is based upon animated high-schoolers who tackle everyday problems through science. The stories address kid-centric issues and present science encountered in the everyday world. The facilitated shows feature hands-on activities and games for children and their families and are designed for use at science museums, schools, and libraries. (EPSCoR)



The Quarked™ project animation drawing of Ushi (up quark), Danny (down quark), and Harold (up quark) in the proton SUV (Subatomic Universe Vehicle). *Copyrighted and permission granted by KU Center for Research, Inc.*

► **The Drexel University Noyce Scholarship Program (DUNS):** With support from NSF's Robert Noyce Scholarship Program, Drexel University is recruiting science, engineering, and mathematics majors who are committed to teaching mathematics and science in the School District of Philadelphia. Recruitment efforts are focused on the Community College of Philadelphia, the Philadelphia Alliance for Minority Participation, and the Center for Civic Engagement at Drexel University. The first cohort of 15 recipients, 43% of whom are minority students, includes nine undergraduate chemistry majors and six STEM professionals ("career-changers"). The program provides strong teacher preparation addressing content knowledge, pedagogical knowledge, learner knowledge and technology integration. Mentoring and induction activities provide support to the new teachers. To broaden the exposure of students to teaching, the Noyce Seminar Series provides a venue for Noyce Scholars to interact with teacher leaders, teacher scientists, and experts who are leaders in pedagogy, science and mathematics teaching or scientists with a penchant for teaching. The seminar series has addressed topics such as *Promoting Girls' Inclusion in Mathematics and Science*; *Teaching Math and Science in Philadelphia*; and *Physics on Fifth Avenue*. Noyce Scholars report that their experience in the program has contributed to an increased understanding of the use of technology in the classroom and an increased ability to identify problems and implement action / solutions in teaching situations. (DUE)

Drexel University Noyce Scholarship Program

► **Cyberinfrastructure Creates Middle-School Scientists:** Cyberinfrastructure offers significant promise for changing K-12 classrooms across the nation. An innovative effort that demonstrates its capabilities is being developed by the Center for Embedded Networked Sensing Education (CENSei) at the University of California-Los Angeles. CENSei's web-supported curricular materials allow middle school students to explore scientific data collected from embedded sensors deployed in Southern California ecosystems. CENSei draws on the expertise of education researchers, natural scientists, information scientists, and teachers to overcome the challenges students face in using scientifically rich data. They are investigating how use of an appropriate interface and support for student inquiry can lead to learning in data rich sensor environments. CENSei capitalizes on NSF's investment in the Center for Embedded Network Sensing, a Science and Technology Center. (DRL)

Students at the Center for Embedded Networked Sensing Education (CENSei) at the University of California-Los Angeles.

Teachers are enthusiastic about the FAU Summer Institute.

► **Math and Science Partnership: Teacher Quality and Summer Teacher Institutes:** Improving teacher quality in mathematics and science education, K-12, is a key goal of the Math and Science Partnership (MSP) program. For many Partnerships, the venue of choice for working with teachers is the Summer Institute. Along with an intense focus on subject-matter expertise, the MSP *Institute Partnerships: Teacher Institutes for the 21st Century* emphasize leadership development for teacher participants to become school- and district-based intellectual leaders in mathematics and the sciences. Many of these experienced teachers will acquire a formal credential as a result of their completion of an Institute. Graduates of the Florida Atlantic University Teacher Institute, for example, will receive a master's degree that includes a newly developed strand for middle school mathematics teaching. MSP Summer Institutes respond to the differentiated needs of the teachers they serve. In its work with inservice teachers in central Appalachia, the *Appalachian Mathematics and Science Partnership* (AMSP), a Comprehensive Partnership, reports significant gains with teachers in the project's innovative 2005 summer Algebra Institutes. Pre- and post-test scores for middle and high school algebra teachers document gains of 24% and 18% for reasoning/problem solving and pedagogical content knowledge, respectively, in the southwest Virginia summer institute; 20% and 13% in these same domains in the Tennessee algebra institutes; and 13% and 23% in the Whitesburg, Kentucky, institutes. (DUE)

Talking Tactile Tablet

Student using Talking Tactile Tablet.

► **Talking Tablet Teaches Mathematics:** With the goal of helping teachers provide individualized instruction to students with disabilities—and to do so in the same classroom as students without disabilities—NSF-funded researchers and educators have successfully demonstrated a computer-based learning system for mathematics that can accommodate both visually impaired and sighted students. The system uses text enlargement on normal displays for low vision students, a Talking Tactile Tablet for blind students, and normal displays for fully sighted students. In addition, the system develops a model for each student's understanding of mathematical concepts, and then uses those models to provide problem-solving advice to students regardless of their visual acuity. The student models have been validated in a pilot test of 50 students, and the system is now being tested with over 300 blind, visually impaired, and fully sighted students. (DRL)

Other Performance Indicators

The table below shows the number of people that participate in EHR funded activities.

Number of People Involved in EHR Activities

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Senior Researchers	5,500	4,800	4,800
Other Professionals	2,200	1,700	1,800
Postdoctorates	290	160	200
Graduate Students	3,400	3,400	3,540
Undergraduate Students	19,000	14,000	15,000
K-12 Students	10,500	8,000	9,000
K-12 Teachers	73,000	59,000	60,000
Total Number of People	113,890	91,060	94,340

INFORMATION ON EHR ORGANIZATIONAL EXCELLENCE FUNDS

Appropriated funds are used both for program support and for program management. The following table provides detail on funds in each of these two categories by program. Throughout this chapter, program level funding information reflects only program support. Funds for program management are shown under the Organizational Excellence strategic outcome goal. Funding totals for EHR divisions include program management costs.

EHR Program and Program Management Funding

(Dollars in Millions)

	FY 2007		
	Total Funding	**Program Funding**	**Program Management Funding**
Experimental Program to Stimulate Competitive Research	**$100.00**	**$99.65**	**$0.35**
Research on Learning in Formal and Informal Settings	**215.00**	**210.90**	**4.10**
Discovery Research K-12	107.00	104.07	2.93
Informal Science Educaion	66.00	65.64	0.36
Research and Evaluation on Education in S&E	42.00	41.19	0.81
Undergraduate Education	**196.80**	**193.86**	**2.94**
Course, Curriculum, and Laboratory Improvement	34.00	33.30	0.70
Advanced Technological Education	46.50	45.92	0.58
Scholarships for Service/Cybercorps	11.00	10.80	0.20
Noyce Scholarships	10.00	9.77	0.23
STEM Talent Expansion Program	26.50	26.07	0.43
National STEM Education Digital Library	16.00	15.52	0.48
Excellence Awards in S&E	6.80	6.78	0.02
Math and Science Partnership	46.00	45.70	0.30
Graduate Education	**160.57**	**159.40**	**1.17**
Graduate Teaching Fellows in K-12 Education	47.00	46.80	0.20
Graduate Research Fellowships	88.57	88.03	0.54
Integrative Graduate Education and Research Traineeships	25.00	24.57	0.43
Human Resource Development	**143.85**	**142.41**	**1.44**
Historically Black Colleges and Universities - Undergraduate Program	30.00	29.71	0.29
Louis Stokes Alliances for Minority Participation	40.00	39.66	0.34
Tribal Colleges and Universities Program	12.85	12.42	0.43
Alliances for Graduate Education and the Professoriate	19.00	18.95	0.05
Program for Gender Equity	11.00	10.96	0.04
Research in Disabilities Education	6.00	5.77	0.23
Centers of Research Excellence in Science and Technology	25.00	24.94	0.06
Total, Education and Human Resources	**$816.22**	**$806.22**	**$10.00**

INFORMATION ON EHR REALIGNMENT

FY 2006 Realignment: In FY 2006 EHR plans to merge the Elementary, Secondary and Informal Education (ESIE) and Research, Evaluation and Communication (REC) divisions into the Division of Research on Learning in Formal and Informal Settings (DRL). The REC programs will join together to become the Research and Evaluation on Education in Science and Engineering (REESE) program, building on the existing REC portfolio of the Research on Learning and Education (ROLE) and the Evaluative Research and Evaluation Capacity Building (EREC) programs. Funding for the Interagency Education Research Initiative (IERI) is also incorporated into REESE. In FY 2006, NSF also proposes to move the Math and Science Partnership (MSP) program to the Division of Undergraduate Education (DUE). This proposal does not change any programmatic arrangements of the MSP but simply moves all programs and associated staff from the EHR Office of the Assistant Director to DUE. The MSP budget line item and its associated funding will remain discrete within the DUE budget.

FY 2007 Realignment: In FY 2007 EHR will maintain the new division structure created in FY 2006 and in addition will create the Discovery Research K-12 (DR-K12) program, which is the combination of three programs: Instructional Materials Development (IMD), Teacher Professional Continuum (TPC), and Centers for Learning and Teaching (CLT). While this new program will maintain the strengths of these three existing programs, it will be capable of addressing a series of well-defined “grand challenges” in K-12 education.

Also included in the DRL division are the existing Informal Science Education (ISE) program and the new Research and Evaluation on Education in Science and Engineering (REESE) program.

The NSF Director’s Distinguished Teaching Scholars (DTS) program returns in FY 2007 as a track within a new awards program in DUE: Excellence Awards in Science and Engineering (EASE). The EASE program will also contain tracks for the Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST, formerly in DRL) and the Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM, formerly in HRD).

The following tables provide additional funding details related to the realignment.

Education and Human Resources Funding in FY 2005 Structure

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Percent
EPSCoR	$93.35	$98.72	$100.00	$1.28	1.3%
DUE	154.24	144.14	145.60	1.46	1.0%
MSP	79.06	63.18	46.00	-17.18	-27.2%
DGE	154.75	153.02	160.57	7.55	4.9%
ESIE	182.49	170.29	177.60	7.31	4.3%
REC	60.01	48.87	42.00	-6.87	-14.1%
HRD	119.64	118.47	144.45	25.98	21.9%
Total, EHR	$843.54	$796.69	$816.22	$19.53	2.5%

Education and Human Resources
FY 2006 Current Plan in FY 2007 Structure
(Dollars in Millions)

	FY 2006 Structure					
FY 2007 Structure	EPSCoR	DUE	DGE	DRL	HRD	Total, FY 2007 Structure
EPSCoR	98.72					98.72
DUE		207.32		4.00	0.39	211.71
DGE			153.02			153.02
DRL				215.16		215.16
HRD					118.08	118.08
Total, FY 2006 Structure	$98.72	$207.32	$153.02	$219.16	$118.47	$796.69

EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH $100,000,000

The FY 2007 Budget Request for the Experimental Program to Stimulate Competitive Research (EPSCoR) is $100.0 million, an increase of $1.28 million, or 1.3 percent, over the FY 2006 Current Plan of $98.72 million.

Experimental Program to Stimulate Competitive Research Funding

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
EPSCoR Funding	$93.35	$98.72	$100.00	$1.28	1.3%

About EPSCoR:

EPSCoR has the mission of assisting the Foundation in its statutory function "to strengthen research and education throughout the United States and to avoid undue concentration of such research and education." Hence, the primary goals of the EPSCoR program are 1) to stimulate sustainable improvements in the R&D capacity and competitiveness within the major research universities of the designated EPSCoR jurisdictions, and 2) to advance scientific and engineering capabilities in these jurisdictions for discovery, innovation and overall knowledge-based prosperity. NSF's EPSCoR program currently operates in 25 states plus the Commonwealth of Puerto Rico and the Territory of the Virgin Islands. The States are: AL, AK, AR, DE, HI, ID, KS, KY, LA, ME, MS, MT, NE, NV, NH, NM, ND, OK, RI, SC, SD, TN, VT, WV, and WY.

EPSCoR's programmatic objectives are to:

- Catalyze key research themes and related activities within and between EPSCoR jurisdictions that empower knowledge generation, dissemination and application;
- Activate effective jurisdictional and regional collaborations among academic, government, and private sector stakeholders that advance scientific research, promote innovation and provide multiple societal benefits; and
- Broaden participation in science and engineering by institutions, organizations, and people within and between EPSCoR jurisdictions.

These preceding goals and objectives are strongly aligned with the major actions that have been recommended recently by the National Academies' Committee on Prospering in the Global Economy of the 21st Century. That is, the programmatic objectives are designed to stimulate further scientific and engineering prowess in the twenty-seven EPSCoR jurisdictions. EPSCoR's perspective is that these jurisdictions have significant unused potential for contributing to the Nation's technological-based discovery, innovation and related competitive productivity. This is based on the statistical facts that the twenty-seven EPSCoR jurisdictions contain over 20 percent of the U.S. population and ~25 percent of our secondary institutions of higher education, but are only engaged in ~10 percent of the Nation's funded R&D enterprise.

In general, 55 percent of the funds for the EPSCoR investment portfolio are available for new awards and activities. The remaining 45 percent will be used to fund awards made in previous years. Within the total budget for EPSCoR of $100.0 million, $350,000 supports program management activities. Program funding is $99.65 million.

EPSCoR Priorities for FY 2007:

To pursue its goals/objectives the EPSCoR Office during FY 2007 will employ a portfolio of four complementary investment strategies:
***Research Infrastructure Improvement (RII) Grants* –** Research Infrastructure Improvement Grants are 36-48 month awards of up to $9.0 million total to support infrastructure improvements in research areas selected by the jurisdiction's EPSCoR governing committee as having the best potential to improve future R&D competitiveness. Successful awards will build the core strength and capacity needed to develop collaborative methods for the solution of important problems having both regional and national importance.
***Strength-Based Research Collaborative (SBRC) Grants* –** SBRC awards are 48 month awards of up to a total of $12.0 million to support collaborative groups of scientists and/or engineers focusing on targeted research topics identified by the jurisdictions' EPSCoR governing committees as having regional significance and national importance. SBRC investigator teams may be composed of scientists and/or engineers from either the same or multiple jurisdictions. Successful awards will build and utilize the capacity already developed in the jurisdiction(s) and will lead to innovation and a new level of amplified competitiveness for the collaboration and the whole region.
***Co-Funding* –** Joint support may be provided for meritorious proposals submitted to the Foundation. Co-funding is an internal NSF funding mechanism that does not involve any action on the part of the proposer. EPSCoR co-funding is available to programs in all directorates and offices that fund awards.
***Outreach* –** Financial support is provided for outreach visits by NSF staff to inform the EPSCoR research community about NSF priorities, programs, and policies and to more fully acquaint NSF staff with the R&D resources and potential residing within EPSCoR jurisdictions.

Changes from FY 2006:

Recent goals of EPSCoR have been to a) increase research capacity in participating jurisdictions by competitive infrastructure improvement (RII and RII-like) programs and b) to increase numbers of awards and participants in the EPSCoR jurisdictions by a combination of outreach and proposal co-funding. In general, this capacity-building approach has been successful. Therefore, the EPSCoR program is now poised to enter it next strategic phase entitled "Trajectory toward Sustainable Science-based Success" (i.e., EPSCoR TS^3). The EPSCoR TS^3 concept is based on the implementation of highly complementary investment programs that leverage both infrastructure *capacity* and human *capability* into sustainable research and innovation *competitiveness* for the participating jurisdictions. The RII program expanded in FY 2006 to offer synergistic SBRCs opportunity to take advantage of improved research *capacity* derived from RII projects. The SBRC opportunity will provide jurisdictions with the ability to enhance research *capability* and hence, build greater *competitiveness*.

During FY 2007 the EPSCoR Office expects to provide $61.0 million to fund a combination of new and continuing RII awards. In addition, the Office plans to fund two SBRC awards for a total of $6.0 million. Hence, the RII/SBRC program will require a total of $67.0 million, which represents an increase of $2.0 million over the FY 2006 Current Plan. The increase of $1.28 million in the FY 2007 budget will be allocated to RII/SBRC. Co-funding of proposals submitted from EPSCoR jurisdictions to other research and educational programs at NSF will be funded at $29.0 million. EPSCoR co-funding of SBIR/STTR proposals will be supported at $2.7 million. Approximately $1.3 million will be used to support Outreach activities, workshops, conferences, and various office operational functions. Support for co-funding, new SBIR/STTR projects, and outreach and other activities is similar to the level in the FY 2006 Current Plan.

RESEARCH ON LEARNING IN FORMAL AND INFORMAL SETTINGS $215,000,000

The FY 2007 Budget Request for the Division of Research on Learning in Formal and Informal Settings (DRL) is $215.0 million, a decrease of $160,000, or 0.1 percent, from the FY 2006 Current Plan of $215.16 million.

Research on Learning in Formal and Informal Settings Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Research on Learning in Formal and Informal Settings	$238.76	$215.16	$215.00	-$0.16	-0.1%
Major Components:					
Discovery Research K-12	113.69	93.36	104.07	10.71	11.5%
Informal Science Education (ISE)	62.75	62.70	65.64	2.94	4.7%
Research and Evaluation on Education in S&E	59.36	48.06	41.19	-6.87	-14.3%
NSF Academies for Young Scientists	-	6.94	-	-6.94	-100.0%
Urban Systemic Program	0.15	-	-	-	N/A

About DRL:

In FY 2006, two EHR divisions, Elementary, Secondary, and Informal Education (ESIE) and Research, Evaluation and Communication (REC), will be combined into the Division of Research on Learning in Formal and Informal Settings. This realignment consolidates the science, technology, engineering, and mathematics (STEM) education research, development, and evaluation programs into a single coherent entity and enhances the management of these activities while building on existing strengths. DRL will focus on research on learning at all levels and in both formal and informal settings with a strong, but not exclusive, emphasis on K-12. It will support both basic and applied research on STEM learning at all levels.

DRL programs will directly assist NSF to address several key issues: the need to recruit and retain highly qualified teachers with strong content and pedagogical knowledge in the STEM disciplines; the need to develop, test, and implement K-12 curriculum materials modeled on world-class standards; and the need to enlarge the pipeline of students interested in and educated for careers in STEM fields as well as to educate a more scientifically literate citizenry.

In FY 2007 the Instructional Materials Development (IMD), Teacher Professional Continuum (TPC), and Centers for Learning and Teaching (CLT) programs will be combined to form the Discovery Research K-12 (DR-K12) program. In FY 2006 the Research on Learning and Education (ROLE), Evaluative Research and Evaluation Capacity (EREC), and Interagency Education Research Initiative (IERI) programs will be combined into the Research and Evaluation on Education in Science and Engineering (REESE) program.

In general, 37 percent of the DRL portfolio is available for new awards and activities. The remaining 63 percent funds awards made in previous years. Within the total budget for DRL of $215.0 million, $4.10 million supports program management activities. Program funding is $210.90 million.

DRL Priorities for FY 2007:

DRL's major priorities include the DR-K12 and REESE programs as well as continued emphasis on informal education and evaluation activities.

Research and Evaluation on Education in Science and Engineering (REESE) supports basic and applied research and evaluation that enhances STEM learning and teaching. It supports two types of research – synthesis studies and empirical proposals. Synthesis studies identify areas where the knowledge base in either evaluation or research is sufficiently robust to support strong scientific claims, identify areas important to education research and practice, and propose rigorous methods for synthesizing findings and drawing conclusions. Empirical proposals identify areas that have the potential for advancing discovery and innovation at the frontiers of STEM learning.

Discovery Research K-12 (DR-K12) will build on the programmatic strengths of three existing programs – IMD, TPC, and CLT. Discovery research comprises research, development, and evaluation activities through which knowledge is generated and applied with some immediacy to improve STEM learning and teaching. Discovery Research lies between the long-term, higher-risk research generated by REESE and the large-scale implementation of tested innovations. The merger of the three programs will increase flexibility and agility, focus the resources needed to address acknowledged Grand Challenges in K-12 STEM education, and encourage innovative thinking from the field while continuing to build on the solid foundations of DRL's portfolio.

Informal Science Education (ISE) will continue to emphasize projects that advance informal STEM education nationally and build on lessons learned from education research. Priority is placed on projects that strengthen infrastructure; engage underserved audiences, including young children and older adults; incorporate inquiry in after-school programs; involve the public in the scientific process; and apply new technologies to informal learning.

Evaluation is a strong focus of EHR/DRL. Emphases include the planning and oversight for third-party evaluations of EHR programs and thematic STEM evaluation studies; providing evaluation technical assistance throughout EHR and NSF as well as providing training opportunities and tools to build capacity in the field. EHR's evaluation team coordinates data collection efforts for performance monitoring and responding to GPRA and other federal reporting requirements; disseminates broader information and evaluation findings to various stakeholders; and addresses directorate-wide knowledge management concerns for improved productivity.

Changes from FY 2006:

- The FY 2007 request for **DR-K12** is $104.07 million, an increase of $10.71 million over the FY 2006 Current Plan of $93.36 million. This will allow the program to expand its investments in research, development, and evaluation activities in FY 2007.
- FY 2007 funding for **ISE** is $65.64 million, an increase of $2.94 million over the FY 2006 Current Plan of $62.70 million. This will result in 3-5 additional awards in FY 2007.
- The FY 2007 request for **REESE** is $41.19 million, a decrease of $6.87 million over the FY 2006 Current Plan of $48.06 million. IERI funding ($5.0 million) ended in FY 2006. The remaining decrease of $1.87 million will result in fewer education research and evaluation research efforts within REESE in FY 2007.

- The FY 2007 request for Academies for Young Scientists is zero, a decrease of $6.94 million from the FY 2006 Current Plan. This activity is planned as a demonstration project in FY 2006; no funds are requested in FY 2007 to allow for evaluation of FY 2006 activities. As directed by Congress, EHR will initiate a K-8 pilot program using funds in the FY 2006 EHR appropriation (approximately $7.0 million) and funds from H-1B Non-immigrant Petitioner fees (approximately $7.0 million). The initiative will call for proposals to develop stimulating, intensive STEM learning experiences that engage K-8 students; develop sustainable, district-based partnership demonstration projects; and promote strategies that further develop skills in K-8 STEM teachers.

- In FY 2007 the Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST) program will move to the Division of Undergraduate Education as part of the new Excellence Awards in Science and Engineering (EASE) program.

UNDERGRADUATE EDUCATION $196,800,000

The FY 2007 Budget Request for the Division of Undergraduate Education (DUE) is $196.80 million, a decrease of $14.91 million, or 7.0 percent, from the FY 2006 Current Plan of $211.71 million.

Undergraduate Education Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Curriculum, Laboratory and Instructional Development	$94.48	$88.13	$86.50	-$1.63	-1.8%
Workforce Development	63.98	60.40	64.30	3.90	6.5%
Math and Science Partnership	79.06	63.18	46.00	-17.18	-27.2%
Total, DUE	$237.52	$211.71	$196.80	-$14.91	-7.0%
Selected Programs:					
Advanced Technological Education	44.48	44.93	45.92	0.99	2.2%
Robert Noyce Scholarship Program	7.57	8.77	9.77	1.00	11.4%
Scholarship for Service	13.66	10.30	10.80	0.50	4.9%
STEM Talent Expansion Program	24.53	25.57	26.07	0.50	2.0%

Totals may not add due to rounding.

About DUE:

DUE is the NSF focal point for excellence in undergraduate STEM education. DUE programs emphasize innovative development and quality improvement in (a) learning, teaching, curricula, laboratories, and (b) the workforce for our 21st century. DUE leads and leverages support for projects that foster inquiry-based learning for a broad spectrum of undergraduate students. This includes those majoring in STEM disciplines, prospective K-12 teachers, technicians for industry, and citizens generally educated for the increasingly technological global society. The emphasis is on 2- and 4-year colleges and universities. DUE improves STEM learning through research into effective methods in educational pedagogy for STEM disciplines, development of faculty, support for new instructional materials, and the reform of courses, laboratories, and curricula. The result is the increase in quality and quantity of the science and engineering workforce.

In general, 72 percent of the DUE portfolio is available for new awards and activities; the remaining 28 percent funds awards made previously. Each year DUE receives over 2,300 proposals and expects to fund approximately 230 new awards in FY 2007 – about 10 percent of proposals received. Within the total budget for DUE of $196.80 million, $2.94 million supports program management activities. Program funding is $193.86 million.

DUE Priorities for FY 2007:

The Curriculum, Laboratory, and Instructional Development Programs are transforming many areas in undergraduate education. DUE is responding to the challenge of reduced funding by transforming its core program of CCLI based on a cyclic model of innovation that includes knowledge production and improvement of practice.

- The **Course, Curriculum, and Laboratory Improvement** (CCLI) program strengthens the Nation's high-quality undergraduate STEM education by supporting research and innovation in undergraduate STEM teaching and learning, new learning materials, faculty expertise, assessment, and evaluation. It supports the innovative educators who build the STEM workforce.

- The **Robert Noyce Scholarship Program** encourages talented STEM undergraduate students and postgraduate professionals to become K-12 mathematics and science teachers. It offers scholarships to juniors and seniors majoring in mathematics, science or engineering, and stipends for science, mathematics, or engineering professionals in the workforce seeking to become teachers. Projects help recipients obtain certification and become math and science teachers in high-need K-12 schools.

- The **STEM Talent Expansion Program** (STEP) supports colleges and universities to increase the number of U.S. citizens and permanent residents receiving associate or baccalaureate degrees in established or emerging STEM fields. It also supports educational research on associate or baccalaureate degree attainment in STEM.

- The **National STEM Education Digital Library** (NSDL) is an online network of learning environments and resources for STEM education at all levels in both formal and informal settings. The national digital library program supports projects that provide stewardship for the content and services needed by major communities of learners or that develop services to support users, collection providers, and integration efforts, and enhance the impact, efficiency, and value of the library.

- The **Federal Cyber Service: Scholarship for Service** (SfS) program builds a cadre of professionals in the federal sector with the skills required to protect the Nation's critical information infrastructure. Scholarships provide full tuition, fees, and stipends in exchange for service in federal agencies after graduation. Capacity building grants improve the quality of academic programs and increase the number of information assurance and computer security professionals.

- **Advanced Technological Education** (ATE) emphasizes two-year colleges and supports improvement in technician education in the science- and engineering-related fields that drive the Nation's economy. The ATE program supports 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. The program also supports articulation between two-year and four-year programs for K-12 prospective teachers in technological education and applied research relating to technician education.

- The **Math and Science Partnership (MSP)** program at NSF is a research and development effort for building capacity and integrating the work of higher education, especially its STEM disciplinary faculty, with that of K-12 to strengthen and reform science and mathematics education. MSP seeks to improve student outcomes in mathematics and science for all students, at all K-12 levels. MSP continues support for its existing portfolio of *Comprehensive Partnerships*, *Targeted Partnerships*, *Teacher Institutes for the 21st Century*, and *Research, Evaluation and Technical Assistance* (RETA) projects, including the new *Institutes* to be awarded with funds appropriated in FY 2006. The *Teacher Institutes for the 21st Century* reflect the enthusiasm and disciplinary spirit of the original NSF Institutes, while responding to 21st century needs for accomplished teachers with expertise in the intellectual substance of school mathematics and the sciences and in the special knowledge needed for their teaching. Graduates of the Institutes will be the mathematics/science specialists in grades K-5 and the curricular leaders of mathematics and the sciences in the secondary grades. In addition to the *Teacher Institutes for the 21st Century*, which stress intensive professional and leadership development for each teacher participant over multiple years, a number of the large *Comprehensive* *and Targeted Partnerships* in the MSP portfolio include Summer Institutes designed to provide teacher enhancement of lesser intensity, thus serving the differentiated needs of teachers for improved subject-matter knowledge and pedagogical expertise.

- The Excellence Awards in Science & Engineering (EASE) will combine three programs designed to recognize excellence. The Distinguished Teaching Scholars (DTS) program will return in FY 2007. It recognizes individuals who contribute significantly to integrating their discipline scholarship and student education. The Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST), formerly in DRL, reward career excellence for elementary and secondary grade level teachers. The Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM), formerly in HRD, identify outstanding contributions that enhance participation of underrepresented groups in STEM.

Changes from FY 2006:

<u>Curriculum, Laboratory, and Instructional Development Programs</u>

- The FY 2007 request for **CCLI** is $33.30 million, a decrease of $2.63 million from the FY 2006 Current Plan of $35.93 million. Fewer new awards will be supported in FY 2007 as the program introduces phases that help prioritize efforts in this area.

- FY 2007 funding for the **Noyce Scholarship** program is $9.77 million, an increase of $1.0 million over the FY 2006 Current Plan of $8.77 million. This FY 2007 increase will fund two additional awards that support up to an additional 80 K-12 science and mathematics teachers.

- The FY 2007 request for **STEP** is $26.07 million, an increase of $500,000 over the FY 2006 Current Plan. This will permit one or two added awards over the approximately 20 expected in FY 2006.

- The FY 2007 request for **NSDL** is $15.52 million. This is an increase of $500,000 over the FY 2006 Current Plan of $15.02 million and will allow projects to expand the number of users in NSDL.

<u>Workforce Development Programs</u>

- FY 2007 funding for **SfS** is increased by $500,000 over the FY 2006 Current Plan to $10.80 million, which will support an approximate 10 percent increase in the number of active students.

- In FY 2007, funding for **ATE** is increased to $45.92 million from $44.93 million in the FY 2006 Current Plan. Two new additional projects or one additional center will be funded with this increase.

- Funding for the **Higher Education Centers for Learning and Teaching** ended with the $1.0 million in FY 2006 as the final continuing grant increment for this cross-directorate program.

- **EASE** will be funded at $6.78 million. This includes: the **DTS** program at $1.60 million, the **PAEMST** program at $4.58 million, and the **PAESMEM** program at $600,000.

<u>Math and Science Partnership</u>

- FY 2007 funding for **MSP** is decreased to $45.70 million from $62.88 million in FY 2006. This will provide support for (a) existing awards and (b) data collection, evaluation, knowledge management and dissemination.

GRADUATE EDUCATION $160,570,000

The FY 2007 Budget Request for the Division of Graduate Education (DGE) is $160.57 million, an increase of $7.55 million, or 4.9 percent, over the FY 2006 Current Plan of $153.02 million.

Graduate Education Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Graduate Education	$154.75	$153.02	$160.57	$7.55	4.9%
Major Components:					
Integrative Graduate Education and Research Traineeships (IGERT)	24.31	23.43	24.57	1.14	4.9%
Graduate Research Fellowships (GRF)	87.87	85.37	88.03	2.66	3.1%
Graduate Teaching Fellowships in K-12 Education (GK-12)	41.66	43.05	46.80	3.75	8.7%

About DGE:

DGE investments support graduate students and innovative graduate programs to prepare tomorrow's leaders in science and engineering. DGE support for science, technology, engineering, and mathematics (STEM) graduate education supports the creation of a diverse STEM workforce to meet the needs of the Nation in the 21st century. DGE accomplishes this by providing fellowships and traineeships, by supporting innovations in STEM graduate education to prepare students for the challenges of the new century, and by building 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.

DGE meets its objectives through three graduate education programs: the Integrative Graduate Education and Research Traineeship Program (IGERT), the Graduate Research Fellowship Program (GRF), and the Graduate Teaching Fellows in K-12 Education program (GK-12). Approximately 4,665 graduate fellowships and traineeships will be supported NSF-wide in FY 2007.

In general, 47 percent of the DGE portfolio is available for new awards and activities. The remaining 53 percent funds awards made in previous years. Within the total budget for DGE of $160.57 million, $1.17 million supports program management activities. Program funding is $159.40 million.

DGE Priorities for FY 2007:

- The **Integrative Graduate Education and Research Traineeship** program is an NSF-wide program administered by DGE. IGERT prepares U.S. doctoral students to lead the Nation in advancing knowledge in emerging areas of research and to pursue successful careers in academia, industry or the public sector. IGERT (institutional) awardees prepare doctoral students by integrating research and education in innovative ways that are tailored to the unique requirements of newly emerging interdisciplinary fields and new career options. IGERT campuses train students to be leading scientists and engineers in the 21st century, provide several trainees with international experiences, and focus on broadening participation. Approximately 1,385 IGERT trainees will be supported across NSF in FY 2007.

- The **Graduate Research Fellowship** (GRF) Program strategically invests in intellectual capital, providing support to individuals who are pursuing graduate education. It prepares the most promising science, mathematics, and engineering students in the U.S. for a broad range of disciplinary and cross-disciplinary careers. It offers three years of financial support, which may be used by students over a five-year period, providing a flexible operational framework. In FY 2007, priorities include broadening participation in the applicant and awardee pools.

  Since 1952, over 41,000 U.S. students have received GRFs. In FY 2007 approximately 2,280 fellows will be supported, primarily with DGE funds. The Directorates for Engineering and Computer and Information Science and Engineering also provide support for the GRF program. Although at early stages of their careers, Fellows begin to build distinguished records of accomplishment.

- The **Graduate Teaching Fellows in K-12 Education** program (GK-12) supports fellowships and associated training that enable graduate students in NSF-supported STEM disciplines to acquire additional skills that will broadly prepare them for professional and scientific careers. Through interactions with teachers in K-12 schools, graduate students improve communication and teaching skills while enriching STEM instruction in these schools. Approximately 1,000 GK-12 fellows will be supported NSF-wide in FY 2007.

Changes from FY 2006:

Approximately 1,050 new awards will be made by DGE in FY 2006. IGERT and GK-12 awards are made to institutions and GRF awards are made to individuals. Increased funding in the FY 2007 request of $7.55 million that will be directed towards the following:

- **IGERT.** Each year IGERT receives more excellent proposals than can be funded. In the current FY 2006 competition, the IGERT program received 82 full proposals and expects to make approximately 24 awards. The FY 2007 request for IGERT within EHR is $24.57 million, an increase of $1.14 million over the FY 2006 Current Plan. This increase, along with R&RA funding, will support 25 additional U.S. doctoral students.

- **GRF.** In FY 2006, DGE received over 8,100 applications, and was able to award approximately 900 fellowships. The EHR FY 2007 request for GRF is $88.03 million, an increase of $2.66 million over the FY 2006 Current Plan. This increase, along with R&RA support from CISE and ENG, will provide support for an additional 65 graduate students.

- **GK-12.** Each year GK-12 receives more excellent proposals than can be funded. In the FY 2006 competition, the GK-12 program received 140 proposals, and will make approximately 27 awards. The EHR FY 2007 request for GK-12 is $46.80 million, an increase of $3.75 million over the FY 2006 Current Plan. This increase, along with R&RA support, will allow NSF to fund 50 additional doctoral students.

HUMAN RESOURCE DEVELOPMENT $143,850,000

The FY 2007 Budget Request for the Division of Human Resource Development (HRD) is $143.85 million, an increase of $25.77 million, or 21.8 percent, over the FY 2006 Current Plan of $118.08 million.

Human Resource Development Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Undergraduate/Graduate Student Support	$70.83	$70.51	$82.85	$12.34	17.5%
Research and Education Infrastructure	33.19	32.51	44.00	11.49	35.3%
Opportunies for Women and Persons with Disabilities	15.14	15.06	17.00	1.94	12.9%
Total, HRD	$119.16	$118.08	$143.85	$25.77	21.8%

About HRD:

HRD supports programs and activities that enhance the quantity, quality and diversity of individuals engaged in U.S. science, technology, engineering, and mathematics (STEM). HRD plays a central role in increasing opportunities in STEM education for individuals from historically underserved populations – particularly minorities, women and persons with disabilities – as well as the educators, researchers, and institutions dedicated to serving these populations.

In general, 39 percent of the HRD portfolio is available for new awards and activities. The remaining 61 percent funds awards made in previous years. Within the total budget for HRD of $143.85 million, $1.44 million supports program management activities. Program funding is $142.41 million.

HRD Priorities for FY 2007:

The FY 2007 Request places special emphasis on programs with a proven track record of broadening participation in the science and engineering workforce. Five highly successful programs are focal points for linking activities in EHR with NSF's R&RA directorates to strengthen collaborations that integrate research and education:

- Louis Stokes Alliances for Minority Participation (LSAMP),
- Alliances for Graduate Education and the Professoriate (AGEP),
- Centers of Research Excellence in Science and Technology (CREST),
- Tribal Colleges and Universities Program (TCUP), and
- Historically Black Colleges and Universities Undergraduate Program (HBCU-UP).

Changes from FY 2006:

In FY 2007 the Presidential Awards for Excellence in Science, Mathematics and Engineering Mentoring program will move to the Division of Undergraduate Education as part of the Excellence Awards in Science and Engineering program.

<u>Undergraduate/Graduate Student Support</u>

- **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. LSAMP will expand the number of alliances to enhance the geographical balance of its portfolio. The Bridge to the Doctorate (BD) initiative supports the initial two years of graduate study for selected LSAMP baccalaureate degree recipients. Twenty BD supplements are anticipated in FY 2007. LSAMP funding for FY 2007 is $39.66 million, an increase of $4.66 million over the FY 2006 Current Plan.

- **Historically Black Colleges and Universities-Undergraduate Program** (HBCU-UP) supports awards that 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. In FY 2007 HBCU-UP will also support targeted infusion projects to enhance innovative STEM programs and activities at HBCUs. HBCU-UP funding for FY 2007 is $29.71 million, a $4.53 million increase over the FY 2006 Current Plan.

- **Tribal Colleges and Universities Program** (TCUP) promotes the improvement of STEM instructional and community outreach programs, with an emphasis on the leveraged use of information technologies at Tribal Colleges and Universities, Alaska Native-serving institutions and Native Hawaiian-serving institutions. In FY 2007, TCUP will also support teacher education programs, as well as targeted projects to improve STEM programs at TCUs. TCUP funding for FY 2007 is $12.42 million, an increase of $3.15 million over the FY 2006 Current Plan.

<u>Research and Education Infrastructure</u>

- **Alliances for Graduate Education and the Professoriate** (AGEP) implement innovative models for increasing STEM Ph.D. attainment among students from underrepresented minority populations and encouraging those students to enter the professoriate. In FY 2007 AGEP will facilitate bridging of LSAMP BD fellows into AGEP, enhance recruitment of new enrollees, and enhance retention/advancement of AGEP participants. The projected impact is to increase by 30 percent annual new enrollment into AGEP institutions and annual minority Ph.D. production in AGEP alliances. AGEP institutions accounted for approximately 45 percent of the total minority Ph.D.s awarded in NSF-supported fields in 2004. AGEP funding for FY 2007 is $18.95 million, an increase of $4.45 million over the FY 2006 Current Plan.

- **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. The HBCU Research University Science and Technology (THRUST) program (commonly known as RISE) strengthens the research capacity of doctoral degree granting Historically Black Colleges and Universities in STEM disciplines by investing in collaborative research, training, equipment and doctoral student support. CREST funding for FY 2007 is $24.94 million, an increase of $7.04 million over the FY 2006 Current Plan. This increase will be used to support 2 additional CREST centers and several THRUST sites.

<u>Opportunities for Women and Persons with Disabilities</u>

- The **Program for Gender Equity** (PGE) supports research, dissemination and adaptation projects that lead to change in education policy and practice with the aim of broadening female participation in STEM. PGE funding for FY 2007 is $10.96 million, a $1.28 million increase above the FY 2006 Current Plan. This increase will support large-scale implementation of proven best practices.

- The **Research in Disabilities Education** (RDE) program supports efforts to increase the participation and achievement of individuals with disabilities in STEM education and careers. RDE funding for FY 2007 is $5.77 million, an increase of $660,000 over the FY 2006 Current Plan, enabling support for an additional alliance.

H-1B NONIMMIGRANT PETITIONER FEES $100,000,000

The FY 2007 H-1B Nonimmigrant Petitioner Fees are projected to be $100.0 million, equivalent to the FY 2006 projection.

H-1B Nonimmigrant Petitioner Fees Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Estimate	Change over FY 2006 Amount	Change over FY 2006 Percent
H-1B Nonimmigrant Petitioner Fees Funding	$25.95	$100.00	$100.00	-	-

Beginning in FY 1999, Title IV of the American Competitiveness and Workforce Improvement Act of 1998 (P.L. 105-277) established an H-1B Nonimmigrant Petitioner Account in the general fund of the U.S. Treasury for fees collected for each petition for alien nonimmigrant status. That law required that a prescribed percentage of funds in the account be made available to NSF for the following activities:

- Computer Science, Engineering, and Mathematics Scholarships (CSEMS). The program supported grants for scholarships to academically-talented, financially needy students pursuing associate, baccalaureate, or graduate degrees in computer science, computer technology, engineering, engineering technology, or mathematics. Grantee institutions awarded scholarships of up to $2,500 per year for two years to eligible students.
- Grants for Mathematics, Engineering, or Science Enrichment Courses. These funds provided opportunities to students for enrollment in year-round academic enrichment courses in mathematics, engineering, or science.
- Systemic Reform Activities. These funds supplemented the rural systemic reform efforts administered under the Division of Educational System Reform (ESR).

In FY 2001, Public Law 106-311 increased the funds available by increasing the petitioner fees. Also, the American Competitiveness in the 21st Century Act (P.L. 106-313) amended P.L. 105-277 and changed the way petitioner fees were to be expended.

- The CSEMS activity continued under P.L. 106-313 with a prescribed percentage of H-1B receipts. The maximum scholarship duration was four years and the annual stipend was $3,125. Funds for this scholarship program totaled 59.5 percent of the total H-1B funding for NSF.
- Private-Public Partnerships in K-12. P.L. 106-313 directed the remaining 40.5 percent of receipts toward K-12 activities involving private-public partnerships in a range of areas such as materials development, student externships, and mathematics and science teacher professional development.
- Information Technology Experiences for Students and Teachers (ITEST) developed as a partnership activity in K-12 to increase opportunities for students and teachers to learn about, experience, and use information technologies within the context of STEM, including Information Technology (IT) courses.

In FY 2005, Public Law 108-447 reauthorized H-1B funding. NSF was provided with 40 percent of the total H-1B receipts collected. Thirty percent of H-1B receipts (75 percent of the receipts that NSF receives) are to be used for the Low-income Scholarship Program. Ten percent of receipts (25 percent of the receipts that NSF receives) are designated for support of the Grants for Mathematics, Science, or Engineering Enrichment Courses.

Low-income Scholarship Program. Eligibility for the scholarships was expanded from the original fields of computer science, engineering, and mathematics to include "other technology and science programs designated by the Director." The maximum annual scholarship award amount was raised from $3,125 to $10,000. NSF may use up to 50 percent of funds "for undergraduate programs for curriculum development, professional and workforce development, and to advance technological education." Because of the changes, the program has been renamed from CSEMS to Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM).

Since its inception the low-income scholarship program has received approximately 1,300 proposals from all types of colleges and universities and has made awards for 553 projects. Approximately 40,000 students have received scholarships ranging from one to four years. In addition to scholarships, projects include student support activities featuring close involvement of faculty, student mentoring, academic support, and recognition of the students. Such activities are important in recruiting and retaining students in high-technology fields through graduation and into employment.

ITEST Grants for Mathematics, Science, or Engineering Enrichment Courses. The ITEST program invests in K-12 activities, including informal education programs for middle and high school students and teachers that are intended to stimulate interest in high technology fields and that emphasize IT-intensive STEM subject areas. ITEST provides substantive learning opportunities that expand upon science experiences received as part of formal classroom instruction. The three categories of awards include: (1) *Youth Projects* for school-age children, grades 7-12; (2) *Comprehensive Projects* that include opportunities for STEM teachers to gain familiarity with IT that can be transported to their classrooms; and (3) the *ITEST Learning Resource Center* that serves as a national resource disseminating best practices, research on student learning, and strategies for project evaluation.

The ITEST portfolio consists of 53 local projects that allow students and teachers to work hand-in-hand with scientists and engineers on extended research projects, ranging from biotechnology to environmental resource management to programming and problem-solving. Projects draw on a wide mix of local resources, including universities, industry, museums, science and technology centers, and school districts. ITEST engages both informal and formal communities in order to identify the characteristics of informal settings – content and format – that make them successful for a wide range of young people, especially those not successful in traditional school settings. Through a $53.0 million federal investment, ITEST impacts 75,000 students (grades 6-12), 3,000 teachers and 1,300 parents / caregivers. Interest in ITEST continues. In FY 2006, ITEST expects to receive over 160 proposals, about the same as in FY 2005, with a success rate of about 15 percent.

In November 2005, Public Law 109-108 was signed and directed EHR to initiate a K-8 pilot program using funds in the FY 2006 EHR appropriation. EHR proposes to use approximately $7 million of funds from its formal K-12 programming and approximately $7 million of funds from H-1B nonimmigrant petitioner fees for this pilot. The initiative, Academies for Young Scientists, will call for proposals to develop stimulating, intensive STEM learning experiences that engage K-8 students; develop sustainable, district-based partnership demonstration projects; and promote strategies that further develop skills in K-8 STEM teachers. This activity is a demonstration project in FY 2006 and thus no funds are requested in FY 2007.

H-1B Financial Activities from FY 1999 - FY 2005

(Dollars in Millions)

	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Receipts	**$26.61**	**$48.61**	**$88.34**	**$61.04**	**$65.34**	**$0.57**	**$83.68**
Obligations incurred							
Computer Science, Engineering, and Mathematics Scholarships	0.26	23.16	68.37	34.69	25.30	33.91	0.54
Grants for Mathematics, Engineering or Science Enrichment Courses	-	0.20	4.22	5.83	16.27	-	-
Systemic Reform Activities	-	1.70	3.70	3.97	5.00	2.50	2.72
Private-Public Partnership in K-12[1/]	-	-	2.22	12.82	-	20.87	22.69
Total Obligations	**$0.26**	**$25.06**	**$78.51**	**$57.31**	**$46.57**	**$57.28**	**$25.95**
Unobligated Balance end of year	$26.35	$49.89	$59.72	$63.45	$83.90	$29.10	$89.58

1/P.L 106-313 directs that 15 percent of the H-1B Petitioner funds go toward K-12 activities involving private-public partnerships in a range of areas such as materials development, student externships, math and science teacher professional development, etc.

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION $240,450,000

The FY 2007 Budget Request for the Major Research Equipment and Facilities Construction (MREFC) account is $240.45 million, an increase of $49.57 million, or 26.0 percent, above the FY 2006 Current Plan of $190.88 million.

Major Research Equipment and Facilities Construction Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change Over FY 2006 Amount	Change Over FY 2006 Percent
Major Research Equipment and Facilities Construction	$165.14	$190.88	$240.45	$49.57	26.0%

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.

MREFC Account Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006[1] Current Plan	FY 2007 Request	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate
Ongoing Projects								
ALMA	49.30	45.14	47.89	47.07	37.37	20.98		
EarthScope	44.80	46.40	27.40					
IceCube	48.10	46.25	28.65	22.38	11.33	0.95		
NEON			12.00	12.00	20.00	30.00	26.00	
SODV	6.08	53.09	42.88					
SPSM	16.86		9.13					
DOJ Judgment			3.00					
New Starts								
ARRV			56.00	42.00				
OOI			13.50	48.00	77.00	78.00	53.00	40.00
AdvLIGO			-	28.48	42.81	46.31	36.25	22.90
Totals	$165.14	$190.88	$240.45	$199.93	$188.51	$176.24	$115.25	$62.90

Totals may not add due to rounding.

Estimates for FY 2008 and beyond do not reflect policy decisions and are presented for planning purposes only.

[1]The FY 2006 Current Plan excludes $45.68 million carried forward from previous years. This includes an unobligated balance of $14.88 million from FY 2005 distributed pro rata among ALMA, EarthScope, IceCube and SODV; and an additional carryover of $2.17 million for EarthScope, $6.59 million for IceCube, $8.80 million for SODV, and $13.17 million for SPSM.

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, the number of funding requests for the construction of major research facilities and equipment from the S&E community has increased. Many of these requests have received outstanding reviews from research peers, program staff, management and policy officials, and the National Science Board. NSF's FY 2007 request for the MREFC account positions the agency to meet the future needs and opportunities of the research community.

In September 2005, NSF released "A Joint National Science Board-National Science Foundation Management report on *Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation*." This "Setting Priorities" report outlines in general terms the changes NSF will implement to its large facilities process over the next year, and was developed largely in response to the February 2004 National Academies' report of the same name. That report recommended an open process for selecting new projects to be funded, establishing well-defined criteria, including maximum community input, and ensuring that the results of this final prioritization should be "discussed, explained and documented". NSF concurs with these recommendations and continues to refine the MREFC process to ensure that decisions are clearly documented and explained and selection criteria clearly articulated.

In accordance with the plan outlined in NSF's Setting Priorities document, NSF continues to develop the guiding documentation for the MREFC process. NSF released its first *Facility Plan*[1] in September, 2005 and will release its second annual *Facility Plan* in March, 2006. The revised *Guidelines for Planning and Managing the Major Research Equipment and Facilities Construction (MREFC) Account*[2] was released in November 2005, and the final management document, the *Facility Manual*[3], is expected to be released during FY 2006.

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.

MREFC projects under consideration must undergo a multi-phase review and approval process[4]. This includes a review by the internal NSF MREFC Panel, comprised of the Deputy Director, the Assistant Directors, the Heads of the Office of Polar Programs and the Office of Cyberinfrastructure, the Chief Financial Officer, and the Deputy Director for Large Facility Projects. The MREFC Panel makes recommendations to the NSF Director with attention to criteria such as scientific merit, importance, readiness, and cost-benefit. These criteria have been modified to align with the criteria recommended by the National Academies. The Director then selects candidates to send to the National Science Board

[1] The 2005 NSF Facility Plan provides an overview of science and engineering research objectives and opportunities that collectively form the context for NSF's current and potential future investments through its MREFC account. (www.nsf.gov/pubs/2005/nsf05058/nsf05058.pdf)
[2] The Guidelines for Planning and Managing the Major Research Equipment and Facilities Construction (MREFC) Account, also referred to as the MREFC Guidelines, clearly define the MREFC planning process, including the policies, and requirements by which candidate projects are identified, developed, prioritized, and selected for funding. (www.nsf.gov/bfa/docs/mrefcguidelines1206.pdf)
[3] The revised Large Facilities Manual and supplemental modules will provide step-by-step guidance to NSF staff and awardees on strong project planning, management and oversight of large facilities; clearly state the policies, procedures and requirements that come into play at each stage of the facility project; and document the experience, knowledge and best practices gained over many years in order to facilitate a process of continuous improvement.
[4] The process is described in greater detail in the *MREFC Guidelines*.

(NSB) for consideration, which then approves, or not, projects for inclusion in future budget requests and establishes priorities in August of each year. The Director, in keeping with the NSB prioritization, selects from the group of approved projects those appropriate for inclusion in a particular budget request to OMB, and after discussion with OMB, to the Congress.

As a general framework for priority setting, NSF assigned priority to projects based on the following criteria:

> <u>First Priority: Ongoing Projects</u> – 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.
>
> <u>Second Priority: NSB-Approved New Starts</u> – 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 have not yet received funding.

NSF believes that the highest priority within the MREFC Account must be the current projects. To that end, the FY 2007 Budget requests funding for the Atacama Large Millimeter Array ($47.89 million); EarthScope ($27.40 million); the IceCube Neutrino Observatory ($28.65 million); the National Ecological Observatory Network ($12.0 million); the Scientific Ocean Drilling Vessel ($42.88 million); and the South Pole Station Modernization Project ($9.13 million). An additional $3.0 million is requested to reimburse the DOJ Judgment Fund for a settlement related to the Polar Aircraft Upgrades project.

NSF's second priority are those projects that have received NSB-approval for inclusion in a budget request but which have not yet received funding. NSF is requesting funding for two new starts in FY 2007. In priority order, these are the Alaska Region Research Vessel ($56.0 million) and the Ocean Observatories Initiative ($13.50 million). Finally, NSF is requesting funding for one new start in FY 2008: Advanced LIGO ($28.48 million in FY 2008).

At the August 2005 meeting of the NSB, NSF recommended and the NSB approved the termination of Rare Symmetry Violating Processes (RSVP) project[5]. NSF remains committed to particle physics as a premier field with unprecedented opportunities for major discoveries in the decades ahead; and NSF will work with its partners to enable U.S. scientists to fully participate in the discoveries ahead. NSF will work with the RSVP project management on an orderly phase-out of activities over the next few months. There were no MREFC funds spent on RSVP.

APPROPRIATION LANGUAGE

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, ~~$193,350,000~~*$240,450,000*, to remain available until expended. *(Science Appropriations Act, 2006.)*

[5] The NSB resolution states "Resolved, that the National Science Board concurs with the recommendation that the Rare Symmetry Violating Processes (RSVP) Project be terminated before the start of construction as a result of the significantly increased construction and operations costs identified during the final stages of planning and the negative impact on the NSF portfolio that would result from proceeding with the project under such circumstances. The National Science Board notes the significant lost scientific opportunity that will result from this project termination."

Major Research Equipment and Facilities Construction Account
Budgetary Resources Summary
(Dollars in Millions)

	Enacted/ Request	Rescission	Carryover/ Recoveries	Transfers	Total Budgetary Resources	Obligations Incurred/ Estimated
FY 2005 Actual	175.05	-1.40	37.17	-	210.82	165.14
FY 2006 Current Plan	193.35	-2.47	45.68	-	236.56	236.56
FY 2007 Request	240.45	-	-	-	240.45	240.45
$ Change from FY 2006	$47.10				$3.89	
% Change from FY 2006	24%				2%	

<u>Explanation of Carryover</u>

Within the Major Research Equipment and Facilities Construction (MREFC) appropriation $45.68 million was carried forward into FY 2006. OPP activities include $13.17 million for South Pole Station Modernization, $10.19 million for the IceCube Neutrino Observatory (IceCube), and $33,795 for the South Pole Safety Project. The remaining MREFC carryover includes $12.94 million for GEO's Scientific Ocean Drilling Vessel (SODV), $5.79 million for GEO's EarthScope, $3.52 million for MPS' Atacama Large Millimeter Array (ALMA) Construction, and $33,819 for MPS' Large Hadron Collider. The amounts reported above include $14.88 million carried over for the Rare Symmetry Violating Processes (RSVP) project that was distributed pro rata to the following projects: ALMA, $3.52 million; EarthScope, $3.62 million; IceCube, $3.60 million; and SODV, $4.14 million.

FIRST PRIORITY: ONGOING PROJECTS IN FY 2007

Ongoing projects in FY 2007 include:

- the Atacama Large Millimeter Array
- EarthScope
- the IceCube Neutrino Observatory
- the National Ecological Observatory Network
- the Scientific Ocean Drilling Vessel, and
- the South Pole Station Modernization project.

Information on these projects, as well as information related to the $3.0 million requested to reimburse the DOJ Judgment Fund for a settlement related to the Polar Aircraft Upgrades project, follows.

Atacama Large Millimeter Array (ALMA)

Project Description: The global ALMA project will be an aperture-synthesis radio telescope operating in the wavelength range from 3 to 0.4 mm. It grew out of a U.S.-only project called the Millimeter Array (MMA). 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 is under construction at 5,000 meter altitude near San Pedro de Atacama in the Second Region of Chile, the ALMA host country.

ALMA VertexRSI test antenna, one of two prototypes constructed at the site of the Very Large Array near Socorro, New Mexico.

Principal Scientific Goals: ALMA will function as the most capable imaging radio telescope ever built, and will bring to millimeter and submillimeter astronomy the high-resolution aperture synthesis techniques of radio astronomy. ALMA will image at 1 millimeter wavelength with the same 0.1 arcsecond resolution achieved by the Hubble Space Telescope 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.

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 approximately 1,000 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 were equal partners in ALMA as originally planned. Japan joined ALMA as a third major partner in 2004, and will deliver a number of enhancements to the baseline instrument. The North American side of the project, consisting of the U.S. and Canada, is led by Associated Universities, Incorporated/National Radio Astronomy Observatory (AUI/NRAO). Funding and execution of the project in Europe is carried out through the European Southern Observatory (ESO). Funding of the project in Japan is carried out through the National Institutes of Natural Sciences of Japan and project execution is the responsibility of the National Astronomical Observatory of Japan. 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 Division of Astronomical Sciences (in MPS). An NSF advisory group, consisting of representatives from the Office of General Counsel, the Office of Budget, Finance, and Award Management, and the Office of Legislative and Public Affairs, serves as a standing ALMA Project Advisory Team (PAT). The NSF Deputy for Large Facility Projects is a member of the PAT and provides 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 NRAO effort on ALMA is carried out under Cooperative Agreement with AUI. Oversight of the full international project is vested in the ALMA Board, whose membership includes an NSF member; coordination and management of the merged international efforts is the responsibility of the Joint ALMA Office, whose staff includes the ALMA Director, Project Manager, and Project Engineer.

Current Project Status: Construction progress continued in FY 2005, both at the site in Chile, and within the ALMA partner countries. The most significant event for the project in FY 2005 was the signing of a production contract for North America's share of the array's antennas. NSF gave permission to AUI/NRAO to proceed with the antenna contract, after intensive testing of the ALMA 12m prototypes was completed, and with the consent of the Joint ALMA Office and the ALMA Board, the project's governing body.

The current baseline schedule for ALMA is specified in version 1 of the ALMA Project Plan, adopted by the ALMA Board in February 2003 following the signature of the ALMA Agreement. While the Project Plan has been under configuration control by the Joint ALMA Office since 2004, the current project schedule was developed prior to the start of ALMA construction activities and the entry of Japan into the project. ALMA is currently 9-12 months behind this existing baseline schedule. However, a detailed reexamination of the project construction baseline and schedule, as well as its operating costs, has been underway since the start of FY 2005, and a set of intensive peer reviews of revised baseline strategies, scrutinizing both the full international project as well as North America’s detailed responsibilities, began in October 2005. After the completion of these reviews in February 2006, a new project baseline will be established.

Major project milestones attained in FY 2005 included:

- Placement of North American production antenna contract
- Road from base to high-altitude site 80% complete
- Placement of contract for three 12m antennas in compact array
- Placement of contracts for foundation and shell of high-altitude Array Operations Site (AOS) technical building

Major milestones for FY 2006 are expected to include:

- Completion of all baseline reviews
- Completion of ALMA site camp
- Critical design reviews for three receiver bands completed
- Placement of European production antenna contract
- Placement of antenna transporter contract
- North American front end integration and test center operational
- Prototype integration testing begins at Socorro NM antenna test facility (interferometry)

Although dependent to some extent upon the adopted new project baseline, major milestones for FY 2007 are expected to include:

- Completion and provisional acceptance of AOS technical building
- Delivery of first North American production antenna to Chile site
- Delivery of first front end to Chile site
- European front end integration and test center operational

Completion of the construction project and the start of full science operations is expected to occur around the end of 2012 under the new baseline.

Funding Profile: A $26.0 million, three-year Design and Development Phase was originally planned for a U.S.-only project, the MMA. 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 of ALMA was initiated in FY 2002.

The current project schedule, which still reflects the original ALMA baseline, calls for U.S.-funded construction activities to continue through 2010, with full project completion at the end of calendar 2011 (early FY 2012), and full operation beginning in early FY 2013. The estimated cost to construct ALMA is $702.0 million, with the U.S. share of the joint array construction estimated to be $344.28 million.

Appropriated and Requested MREFC Funds for ALMA

(Dollars in Millions)

	FY 03 & Earlier	FY04	FY05	FY06 Plan	FY07 Request	FY08	FY09	FY10	Total
ALMA R&D	31.99								$31.99
ALMA Construction	42.31	50.70	49.30	45.14	47.89	47.07	37.37	20.98	$340.76
Unobligated Balance from FY 2005				3.52					$3.52
Total, ALMA	$74.30	$50.70	$49.30	$48.66	$47.89	$47.07	$37.37	$20.98	$376.27

ALMA Funding Profile

(Obligated Dollars and Estimates in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		Grand Total
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	
FY 2001& Earlier	6.50	31.99					$6.50	$31.99	**$38.49**
FY 2002				12.50			-	$12.50	**$12.50**
FY 2003				29.81			-	$29.81	**$29.81**
FY 2004				50.70			-	$50.70	**$50.70**
FY 2005				49.30	1.00		$1.00	$49.30	**$50.30**
FY 2006 Current Plan[1]				48.66	4.00		$4.00	$48.66	**$52.66**
FY 2007 Request				47.89	6.00		$6.00	$47.89	**$53.89**
FY 2008 Estimate				47.07	10.00		$10.00	$47.07	**$57.07**
FY 2009 Estimate				37.37	14.00		$14.00	$37.37	**$51.37**
FY 2010 Estimate				20.98	19.00		$19.00	$20.98	**$39.98**
FY 2011 Estimate					23.00		$23.00	-	**$23.00**
FY 2012 Estimate					28.00		$28.00	-	**$28.00**
FY 2013 Estimate					30.00		$30.00	-	**$30.00**
Subtotal, R&RA	$6.50		-		$135.00		$141.50		
Subtotal, MREFC		$31.99		$344.28		-		$376.27	
Total, Each Stage		**$38.49**		**$344.28**		**$135.00**			**$517.77**

NOTES: Implementation costs are based on the cost review of the original MMA and then projected to ALMA. The expected operational lifespan of this project is at least 30 years. A steady state of about $30.0 million annually is estimated for operations support beginning in about FY 2013. 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. Operations funding is provided through the National Radio Astronomy Observatory.

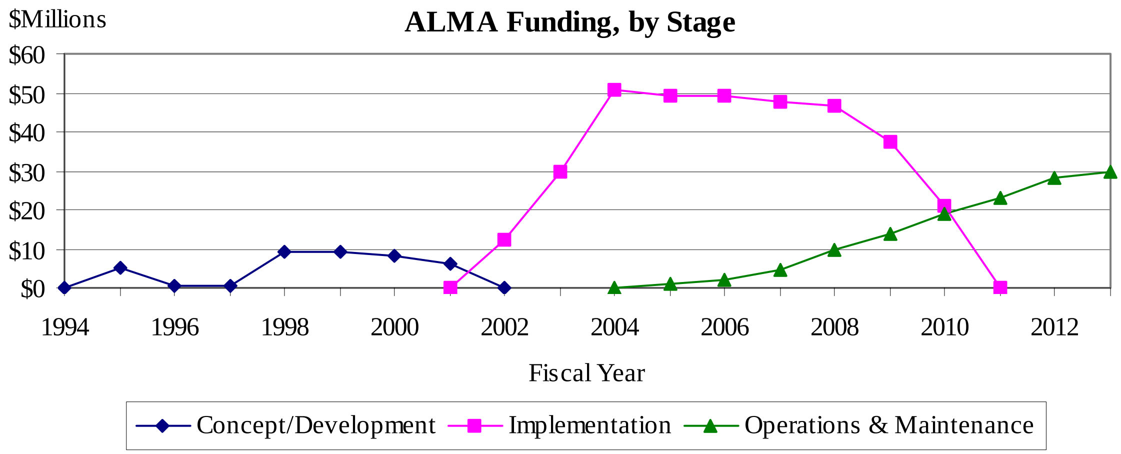
[1]The FY 2006 Current Plan includes $3.52 million of an unobligated balance from FY 2005.

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

- Concept/Development: Prior to FY 1998, 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 support an array of up to 64 12-meter antennas having a total collecting area of 7,200 square meters, with 4 receiver bands extending into the submillimeter. The exact number of antennas will be determined after the completion of the baseline reviews in early 2006. The table describes the U.S. contribution to ALMA. It does not include funds resulting from 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. Full ALMA science operations are anticipated to begin in FY 2013.



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.

Associated Research and Education Activities: Extensive public and student ALMA outreach programs will be implemented in North America, Europe, and Chile as ALMA approaches operational status. A visitors' center will be constructed at the 2,800 meter-altitude Operations Support Facility gateway to the ALMA site near San Pedro de Atacama in northern Chile. The project also supports a fund for the Antofagasta (II) Region of Chile that is used for economic, scientific, technical, social and cultural development, particularly within the nearby towns of San Pedro de Atacama and Toconao.

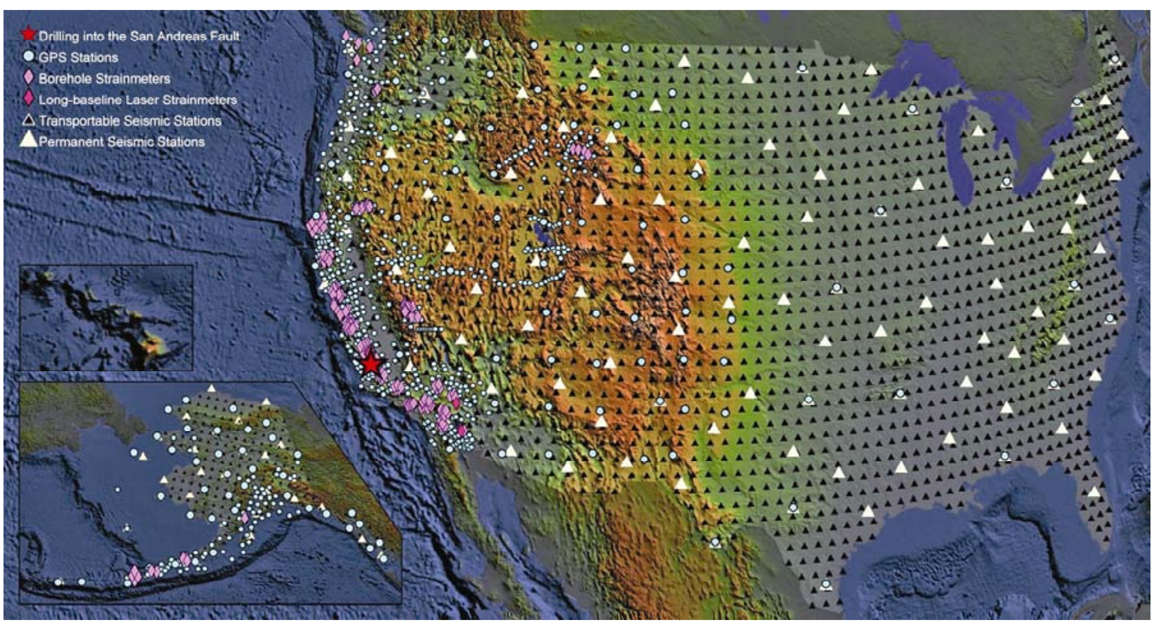
EarthScope

Project Description: The EarthScope Facility 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. EarthScope instrumentation is expected to inhabit nearly every county within the U.S. over the life span of the program.

Principal Scientific Goals: Enhanced understanding of the structure and evolution of the North American continent, including 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 time or retrospectively with the aim of integrating research and education.

Partnerships and Connections to Industry: 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 are 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 3,000 earth scientists and students are expected to use the facility annually. Geotechnical and engineering firms directly use data and models, which will be 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.



The complete EarthScope footprint. 1600 of the transportable sites (moving west to east) and all 2400 campaign stations will continue to be deployed after the conclusion of the MREFC project. Locations of the 2400 campaign stations will be determined through the annual proposal review process; many of these sites likely will change annually. *Credit: EarthScope*

Management and Oversight: The EarthScope Program Director, located in the Earth Sciences (EAR) Division in the Directorate for Geosciences (GEO), provides NSF oversight. The Deep Earth Processes

Section Head (EAR) and a Project Advisory Team including the NSF Deputy Director for Large Facility Projects and staff from GEO, the Office of the General Counsel and the Office of Budget, Finance and Award Management, provide other internal oversight. Following the recommendations of the Large Facilities Management and Oversight guideline documents, external oversight is provided through periodic reviews, including facility construction project baseline reviews and *ad hoc* technical, science, and education and outreach committee meetings, as well as site visits.

Current Project Status: Phase 2 drilling at the San Andreas Fault Observatory at Depth (SAFOD) site concluded successfully on August 9, 2005. The drill crossed the main trace of the San Andreas Fault at a depth of about 3,831 meters (12,570 feet) on August 3, 2005. Geophysical logging and other active data collection concluded successfully in November, 2005. A sensor string was installed during November, 2005, to record data through the winter. In December, 2005, scientists from around the world met at the temporary core repository (USGS, Menlo Park) to examine the core from the Phase 2 drilling and to request samples for scientific investigations. Overall, GPS and seismic station equipment acquisition and installation are slightly behind schedule. The Plate Boundary Observatory (PBO) has installed 239 permanent geodetic stations, 10 borehole strainmeter stations, and one long-baseline. The USArray has installed 88 Transportable Array stations, and installations continue on schedule. Other FY 2005 highlights include the use of USArray seismic data in analyses of the Sumatra-Andaman earthquake (one of the largest earthquakes ever recorded) and a very successful National Meeting. The EarthScope project has been represented at over a dozen professional meetings and conferences through an exhibit booth, presentations, and scientific sessions. Scientific results utilizing data collected by the EarthScope facility have already been presented at national meetings and in professional publications.

The EarthScope Facility Project Execution Plan has been reviewed and updated. The initial milestones are listed below. These milestones are reviewed quarterly and the project underwent a very successful baseline review on September 20–22, 2005. Thus, these milestones are being revised to reflect changes in instrument delivery schedule and other recommendations made by the review panel.

FY 2005 Milestones:

Main hole Phase 2 drilling completed at SAFOD;
Down-hole monitoring instrumentation installed;
Installation of 300 equivalent permanent GPS, 30 equivalent borehole strain, and 3 equivalent long baseline strainmeter systems;
Equipment for 50 portable GS sites available;
Installation of 29 equivalent ANSS and 80 equivalent Transportable Array stations;
Equipment for 720 Flexible Array sites available; and
NSF conducted annual review of project status.

FY 2006 Milestones:

San Andreas Fault site characterization studies carried out;
Installation of 540 equivalent permanent GPS and 100 equivalent borehole strain systems;
Complete installation of 5 long baseline strainmeters;
Equipment for 100 portable GS sites available;
Complete installation of 39 equivalent ANSS stations;
Installation of 220 equivalent Transportable Array stations;
Equipment for 1,200 Flexible Array sites available; and
NSF conducts annual review of project status.

FY 2007 Milestones:

Use site characterization and monitoring data to choose four coring intervals at depth in San Andreas Fault Observatory;
Main hole Phase 3 drilling begins at SAFOD;
Installation of 780 equivalent permanent GPS and 162 equivalent borehole strain systems;
Complete first footprint of USArray (400 Transportable Array stations);
Equipment for 1,680 Flexible Array sites available; and
NSF conducts annual review of project status.

FY 2008 Milestones:

Redeployment of USArray begins;
Main hole Phase 3 drilling completed at SAFOD;
Install permanent monitoring instrumentation in four core intervals and main hole of SAFOD;
Complete installation of 875 equivalent permanent GPS and 175 equivalent borehole strain systems;
Equipment for 2,400 Flexible Array sites available; and
NSF conducts annual review of project status.

FY 2009 – FY 2013 Milestones:

Redeployment of USArray on a continual basis;
Analysis of San Andreas Fault cores, cuttings and logs completed. Continue monitoring at depth;
Ongoing operation and maintenance of the PBO; and
NSF conducts biennial reviews of project status.

Funding Profile: Conceptual planning for the EarthScope project developed over the past decade. NSF funded planning, design and development since FY 1998 through the R&RA account and began funding the implementation of a five-year period of acquisition, construction and commissioning in FY 2003 through the MREFC account. The total project cost for EarthScope facility implementation is $197.44 million.

Appropriated and Requested MREFC Funds for EarthScope
(Dollars in Millions)

	FY 2003	FY 2004	FY 2005	FY 2006 Plan	FY 2007 Request	Total
EarthScope	$29.81	$43.24	$46.97	$46.40	$27.40	$193.82
Unobligated Balance from FY 2005				$3.62		
Total, EarthScope	$29.81	$43.24	$46.97	$50.02	$27.40	$197.44

EarthScope Funding Profile

(Obligated Dollars and Estimates 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				43.24	1.70		$1.70	$43.24	**$44.94**
FY 2005				44.80	4.69		$4.69	$44.80	**$49.49**
FY 2006 Current Plan				52.19	6.72		$6.72	$52.19	**$58.91**
FY 2007 Request				27.40	11.61		$11.61	$27.40	**$39.01**
FY 2008 Estimate					23.41		$23.41	-	**$23.41**
FY 2009 Estimate					30.00		$30.00	-	**$30.00**
FY 2010 Request					31.00		$31.00	-	**$31.00**
FY 2011 Estimate					32.00		$32.00	-	**$32.00**
FY 2012 Estimate					32.00		$32.00	-	**$32.00**
Subtotal, R&RA	$9.36		-		$173.53		$182.89		
Subtotal, MREFC		-		$197.44		-		$197.44	
Total, Each Stage		**$9.36**		**$197.44**		**$173.53**			**$380.33**

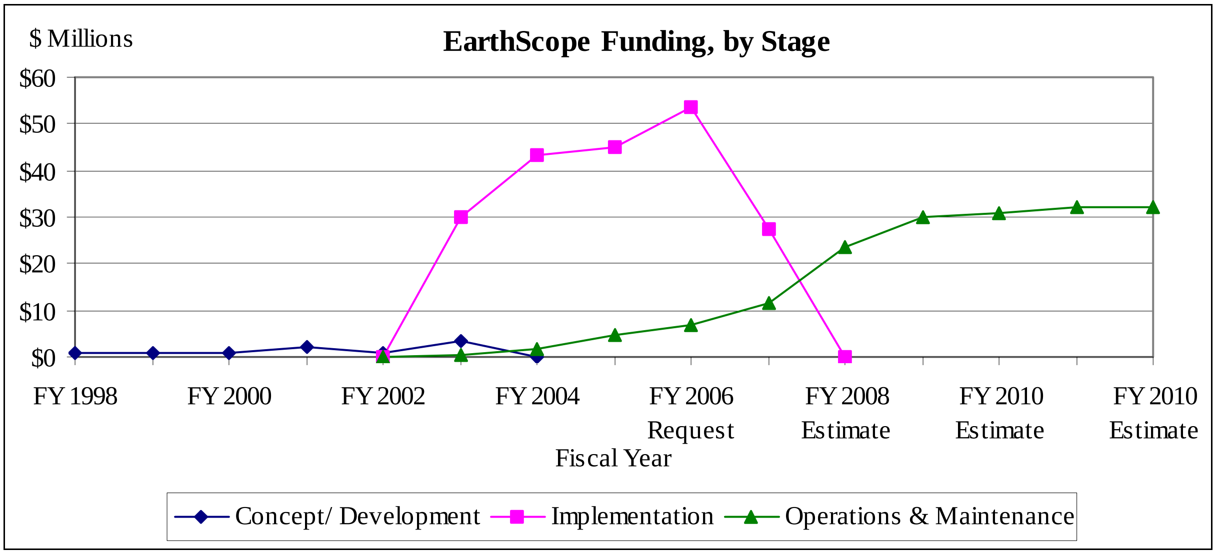
NOTE: Operations and maintenance support is anticipated to increase after FY 2008. The expected operational lifespan of this project is 15 years after construction is complete in FY 2008. Operations estimates for FY 2007 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

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

- Concept/Development: FY 1998-2000 funds were used to support workshops, instrument development, and installation technique development appropriate to EarthScope from existing programs within EAR. Dedicated funding was established for FY 2001-2003 supporting pre-EarthScope activities that facilitated construction and installation. This funding supported meetings, workshops, instrumentation prototype development, installation technique development, and site selection activities.

- Implementation: The project is putting 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.

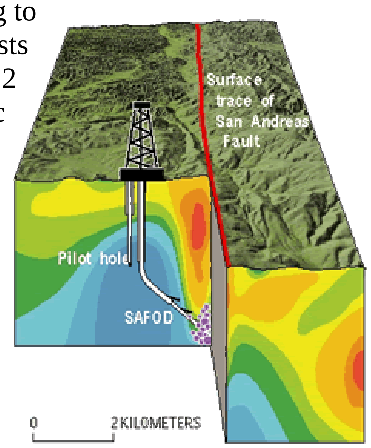
- Operations and Maintenance: Operations and maintenance began to phase-in during the first year of construction. When EarthScope is completed it will be managed, operated and maintained by consortia including participation from host institutions, affiliate organizations, and the user community.



<u>Future Science Support</u>: Along with direct operations and maintenance support for the EarthScope Facility, NSF will support research performed utilizing 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.

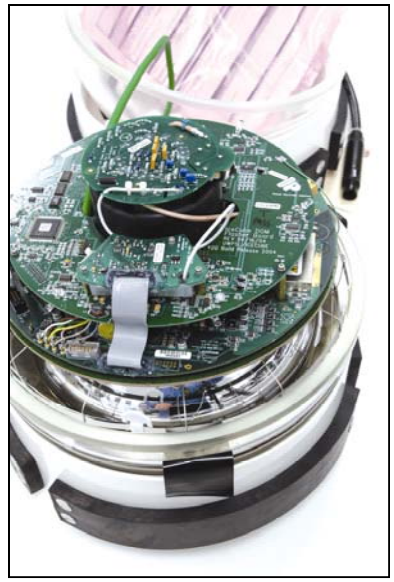
<u>Recent Research Highlight</u>

► **Keeping an Eye on the San Andreas Fault:** Last August, while drilling to create the new San Andreas Fault Observatory at Depth (SAFOD), scientists tapped into the active zone of the San Andreas Fault at a depth of about 2 miles. The drill hole, near Parkfield, California, starts on the Pacific tectonic plate, west of the San Andreas Fault, goes through the active earthquake zone, and ends in the North American Plate, east of the fault. The SAFOD drill hole, part of the broader NSF-supported EarthScope project, will house instruments to collect data at intervals from the surface to the depth where earthquakes form. Fluid pressure, temperature, and geophysical data collected around the clock will be used to observe the physical and chemical changes that take place as earthquakes occur.



Location of the SAFOD drill hole relative to the San Andreas Fault.

IceCube Neutrino Observatory



Pictured in the UW-Madison Physical Sciences Laboratory before being vacuum-sealed, each IceCube DOM is very much like a small computer. A total of 4,200 DOMs, designed to sample high-energy neutrino particles from deep space, are being deployed in 70 deep holes in the Antarctic ice.

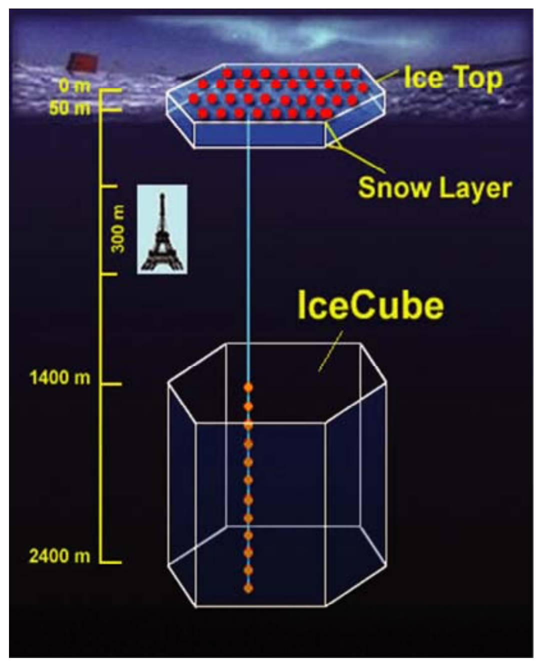
Project Description: IceCube will be the world's first high-energy neutrino observatory and will be located deep within the icecap under the South Pole Station in Antarctica. It represents a new window on the universe, providing unique data on the engines that power active galactic nuclei, the origin 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 construction is being carried out by the IceCube Consortium, led by the University of Wisconsin (UW). Approximately one cubic kilometer of ice is being 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. An array of 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. When completed, 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 principal 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 deploying 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.

Principal Education Goals: IceCube provides a vehicle for helping to achieve national and NSF 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 workforce 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 (one is currently under construction). 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. The Department of Energy, through its Lawrence Berkeley National Laboratory, is also participating.

Management and Oversight: The strong project management structure at UW, which includes international participation, provided the framework for the Start-up Project funded in FY 2002 and FY 2003, and the initiation of full construction with FY 2004 funding. UW has in place an external Scientific Advisory Committee, an external Project Advisory Panel, and a high-level Board of Directors (including the Chancellor) providing oversight of the project. IceCube is externally managed by a Project Director and a Project Manager. Internally, NSF has appointed a Project Coordinator to manage and oversee the NSF award. A comprehensive external baseline review of the entire project (including cost, schedule, technical, and management) was carried out in February 2004. There was a follow-up external cost review in Fall 2004, and comprehensive annual external reviews are planned for each subsequent spring following the annual deployment season. The first such annual review was held in May 2005. Besides annual progress reviews and other specialized reviews, the project provides written monthly progress reports and quarterly reports. NSF conducts site visits, weekly teleconferences with the project managers, and weekly internal NSF project oversight and management meetings. Oversight responsibility for IceCube construction is the responsibility of OPP; support for operations, research, education, and outreach 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 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 primary IceCube project tasks carried out to date are: (1) completion, testing, and shipment to the South Pole of the Enhanced Hot Water Drill (EHWD) system for drilling the required deep-ice holes into which the strings of DOMs will be placed; (2) completion and commissioning of the three planned DOM production and low temperature (-80°C) testing facilities in the U.S., Germany, and Sweden; (3) production, testing, shipment to the Pole, and subsequent re-testing of the DOMs and cables needed for deployment of DOM strings in the 2004/2005 and 2005/2006 austral summer seasons (November to mid-February); (4) design, construction, and installation of the initial data acquisition system at the Pole; (5) completion of plans for commissioning and verification of the initial DOM strings; (6) placement at the Pole of the building that will serve as the IceCube permanent counting house in the 2005/2006 season; (7) during the 2004/2005 season, successful drilling of the first deep hole at the Pole and the deployment of the first IceCube string (60 DOMs), which is now connected to the data acquisition system, fully operational, and functioning well, as well as successful deployment and operation at the Pole of eight surface cosmic ray air shower detector modules (2 DOMs/module); and (8) during the 2005/2006 season, the first test of the production capability of the EHWD and DOM deployment systems, with plans for deployment of up to ten additional strings (as of this writing (January 15, 2006) four additional detector strings have been installed).

Major milestones for IceCube are below:

FY 2004 and FY 2005 Milestones:

- Completed production of digital optical modules and data acquisition and handling system (DAQ)
- Delivered EHWD system and DOM deployment system to the South Pole
- Delivered initial DOM strings, IceTop modules, and initial elements of the DAQ to South Pole
- Assembled the EHWD and DOM deployment systems
- Established drill camp and move new counting house building into place
- Drilled, deployed, and tested initial DOM strings and corresponding IceTop modules

FY 2006 Milestones:

- Ramp up to near-full DOM production at all facilities and IceTop module production
- Drill, deploy and test up to 10 additional DOM strings and corresponding IceTop modules, including installing and testing the associated DAQ elements

Projected outyear milestones (FY 2007-2010) are based on current project planning and represent a general outline of anticipated activities. These activities are also dependent on weather conditions and the Antarctic logistics schedule.

FY 2007-10 Milestones:

- Complete and commission new counting house at the Pole
- Continue DOM and IceTop module production
- Continue to drill, deploy, test, and commission DOM strings (up to 18 strings per season) and the corresponding IceTop modules (two for each DOM string), including installing and testing of the associated DAQ elements
- Begin initial operations of IceCube with strings available in FY 2007
- Complete installation and commissioning

FY 2011 Milestones:

- Commence full operations of IceCube for science

<u>Funding Profile</u>: Startup activities were funded with FY 2002-03 appropriations. Construction was initiated with FY 2004 appropriations. The total project cost for IceCube is $271.77 million. Of this amount, $242.07 million will be from the U.S. and $29.70 million will come from foreign contributions.

Appropriated and Requested MREFC Funds for IceCube
(Dollars in Millions)

	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007 Request	FY 2008	FY 2009	FY 2010	Total
IceCube	$15.00	$24.54	$41.75	$47.62	$46.25	$28.65	$22.38	$11.33	$0.95	$238.47
Unobligated Balance from FY 2005					$3.60					$3.60
Total	$15.00	$24.54	$41.75	$47.62	$49.85	$28.65	$22.38	$11.33	$0.95	$242.07

The funding profile table below reflects actual obligations for past years and anticipated obligations for future years. The differences between these two tables are due to funds appropriated in FY 2002 and FY 2003 but not spent until later years. In addition to the $3.60 million shown in the table above, $6.59 million has been carried over from prior year appropriations into FY 2006 and will be obligated in FY 2006 and later years.

IceCube Funding Profile
(Obligated Dollars and Estimates in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		**Grand**
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	**Total**
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				38.36			-	$38.36	**$38.36**
FY 2005				48.10			-	$48.10	**$48.10**
FY 2006 Current Plan				49.85			-	$49.85	**$49.85**
FY 2007 Request				35.71	0.50		$0.50	$35.71	**$36.21**
FY 2008 Estimate				22.38	1.75		$1.75	$22.38	**$24.13**
FY 2009 Estimate				11.33	2.25		$2.25	$11.33	**$13.58**
FY 2010 Estimate				0.47	3.75		$3.75	$0.47	**$4.22**
FY 2011 Estimate					4.00		$4.00	-	**$4.00**
FY 2012 Estimate					4.00		$4.00	-	**$4.00**
Subtotal, R&RA	$0.50		-		$16.25		$16.75		
Subtotal, MREFC		-		$242.07		-		$242.07	
Total, Each Stage		**$0.50**		**$242.07**		**$16.25**			**$258.82**

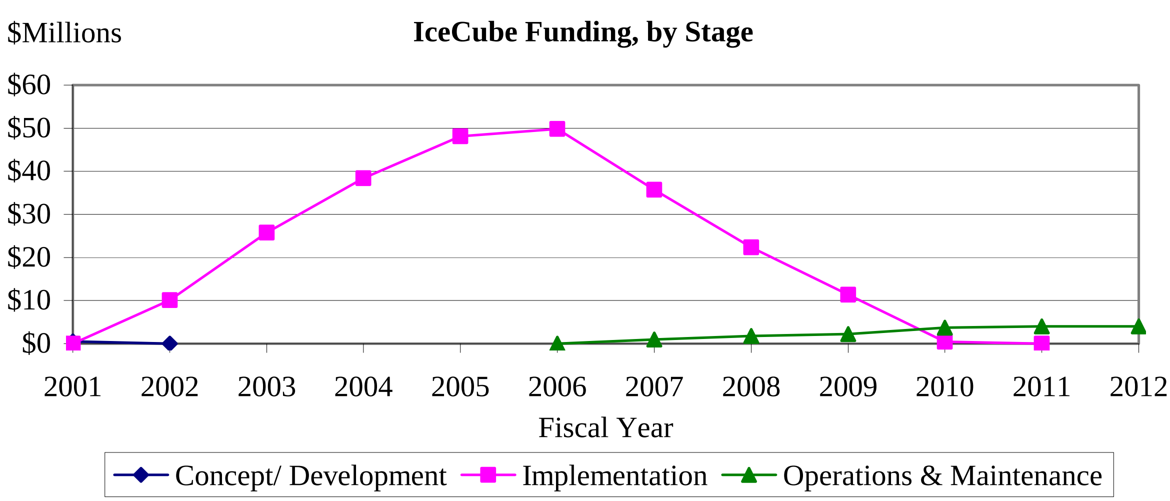
NOTE: The expected operational lifespan of this project is 25 years after construction is complete in FY 2010. Operations support is planned to begin in FY 2007. Corresponding support for conduct of research also must be provided. Current planning calls for international partners to provide a share of the costs. The estimates shown above are for operations and maintenance and have been developed for planning purposes. Efforts are underway to further develop these cost estimates; they will be updated as new information becomes available.

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

- Concept/Development: $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. Those investments focused on state-of-the art drill and electronics development and acquisition.

- Implementation: The total project cost of the IceCube construction project is currently estimated at $271.77 million. Of this amount $242.07 million will be from NSF, and $29.70 million from foreign partners. Construction is planned to extend through FY 2010. A comprehensive baseline review of the IceCube project was conducted in February 2004 to provide a solid project baseline scope, cost, and schedule. The plan is to drill holes and deploy strings of DOMs in each austral summer season (November through mid-February). This began with the successful deployment of the first IceCube string in the FY 2005 austral summer season (2004/2005) and, in FY 2006, the first test of the production capability of the drilling and deployment system. 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 2010.

- 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 2010. Initial operations will begin in FY 2007, ramping up in subsequent years to full science operations in FY 2011. These costs will be shared by the collaborating institutions, domestic and foreign. Of the amounts shown in the table for operations, approximately half are for data analysis that will be carried out by the collaborating U.S. and foreign IceCube institutions, the other half are for direct operations and maintenance support (IceCube-specific logistics, system engineering, operation and maintenance of the data acquisition and data handling 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.

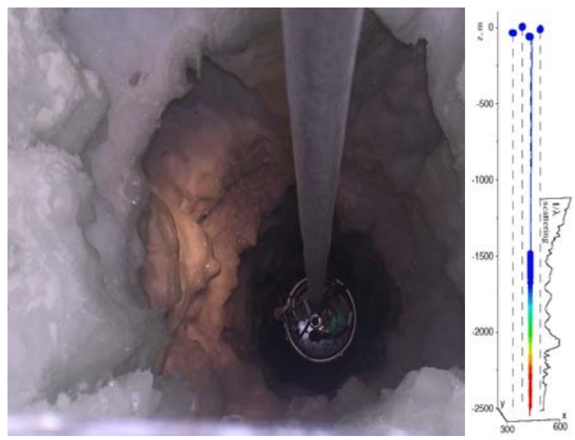


<u>Future Science Support</u>: NSF will support activities at U.S. institutions working on more refined and specific data analyses, data interpretation (theory support), and instrumentation upgrades, through ongoing research and education programs. The annual support for such activities is estimated at $3.0 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 groups 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.

Recent Research Highlight

IceCube, a New Kind of 'Telescope' at the South Pole: A sub-surface observatory that tracks elusive cosmic messengers called neutrinos is now under construction beneath the South Pole. When completed, the IceCube detector array will comprise as many as 80 separate "strings," each containing 60 sensors, that descend vertically more than a mile deep into ancient ice that has been compressed so hard that it is clear as glass. In January 2005, the first string was lowered into a narrow shaft produced by a novel hot-water "drill." When tested, the string met or exceeded its design requirements, and began taking data.



Strings of instruments such as this one will detect the arrival and trajectory of neutrinos, producing data of the sort seen in the diagram on the right. The size of the circle is proportional to the strength of the signal, and the color (from blue to red) indicates relative times of the "hits" recorded by the string's sensors. *Credit: University of Wisconsin*

IceCube, so called because it will eventually extend to a square kilometer of sensors buried between 1,450 and 2,450m below the surface, will observe the arrival of high-energy neutrinos (subatomic particles generated in violent astronomical events in our galaxy or others, such as stellar explosions), record their characteristics, and determine their point of origin in space within 1/2 of a degree.

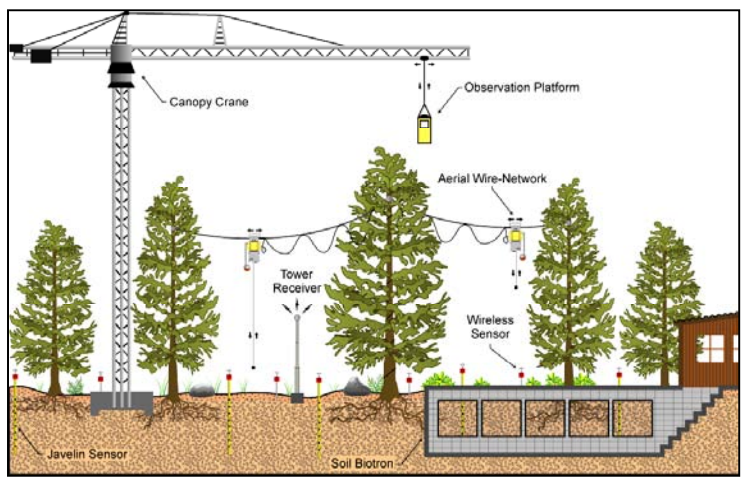
National Ecological Observatory Network (NEON)

Project Description: NEON will be a continental scale research platform consisting of geographically distributed infrastructure for ecological research that is networked via state-of-the-art communications technology. Cutting-edge sensor networks, instrumentation, experimental infrastructure, natural history archive facilities, remote sensing, will be linked via the internet to computational, analytical and modeling capabilities to comprise NEON.

Principal Scientific Goals: NEON will transform ecological research by enabling studies of the biosphere at regional to continental scales, quantifying the strong and weak forces regulating these systems, and predicting the consequences of climate and land use change on the biosphere. Through remote sensing, in-situ observation, experimentation, synthesis, and modeling, the National Ecological Observatory Network will enable new scientific approaches needed to quantify and understand the complex biosphere processes and interactions that operate across local to continental scales.

As a "shared-use" research platform to advance fundamental understanding of the biosphere NEON will facilitate interdisciplinary research on the complex interactions between the biological, physical and human drivers of ecological change. NEON will be used to conduct comprehensive, regional to continental-scale experiments on ecological systems and thus will represent a virtual laboratory for research to obtain a predictive understanding of the biosphere.

Principal Education Goals: The knowledge base NEON will create, its real time and continuous integrated data, simulation and observation capabilities, and its networked communication will be an asset for formal and informal education and training. NEON will foster the NSF goal of integrating research and education by creating a research-intensive and collaborative learning environment. A NEON gateway will provide cutting-edge resources to support informal public education and provide opportunities for citizens to actively participate in scientific investigations. Data from standard measurements made using NEON will be publicly available.



Planning for the National Ecological Observatory Network includes visual rough drafts of sensors and research infrastructure deployed across a forest ecosystem, from the forest canopy to the soil community.

Partnerships and Connections to Industry: Federal agencies such as USGS, EPA and DOE are on the NEON Advisory Board and planning committees. A NEON Federal Agency Coordinating Committee meets on a regular basis[6]. Discussions are underway with the U.S. Department of Agriculture (USDA), USGS and DOE on formal agreements. NEON will be the only observation network that will be able to provide the insitu biospheric component called for in the US Group on Earth Observations Ten-year Strategic Plan. International perspectives are provided through the NEON Advisory Board, which is comprised of Environment Canada and CONABIO, Mexico, and the NEON planning committees, one of

[6] A full list of the members of these committees can be provided on request.

which includes a member of Argentine National Research Council. Private foundations, e.g., the Heinz Center, Nature Serve, and US Landtrust, participate on the NEON design consortium. NEON-generated information will be useful to natural resource industries, such as forestry and fisheries. Resource managers and decision makers will participate in NEON through partnerships; use of its facilities, data, and forecasts; and education, training, and outreach opportunities. NEON's scientific and networking demands will require technological innovations that will foster partnerships with industry for infrastructure development, deployment, and operation.

Management and Oversight: The Division of Biological Infrastructure within the Directorate for Biological Sciences 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 solicitations, etc. The BIO Advisory Committee provides external advice to BIO about specific programmatic elements.

The NEON program officer is a member of the NSF Environmental Observing Networks Task Force and serves on the PATs for other large facility projects, such as the Network for Earthquake Engineering Simulation (NEES) and the Ocean Observatories Initiative (OOI). Coordination with other federal agencies occurs through the NEON Federal Agency Coordinating Committee. In addition, NEON is represented on the Architecture and Data Management task force of the US Group on Earth Observations, the U.S. component of Global Earth Observation System of Systems (GEOSS), an activity of the National Science and Technology Council, Committee on Environment and Natural Resources.

Current Project Status:

In FY 2005, the NEON Design Consortium and Project Office refined the NEON science requirements, developed the scientific facilities and infrastructure reference design, completed the preliminary baseline definition for networking and informatics, formulated the infrastructure requirements for education, training, and outreach, and designed the governance and management structures for NEON as recommended in the 2004 NRC report, "NEON: Addressing the Nation's Environmental Challenges."

Three workshops were conducted to define the cross-cutting needs, challenges, and opportunities in sensors and cyberinfrastructure. The workshops addressed emerging issues of interoperability among evolving observing systems, leveraging emerging technologies and research frontiers, fostering collaboration, and stimulating robust technology development. R&RA supported R&D on environmental sensors, networks, and cyber tools that will advance the development of NEON as a network of nationally deployed infrastructure.

In FY 2006, a research community Consortium (NEON Inc.), which provides a link between NEON planning and construction, was established as a legal entity. The NEON Integrated Science and Education Plan and Networking and Informatics plans were completed. The preliminary project execution plan and design, cost, and management reviews will be conducted. R&RA funds continue to be provided to the Consortium of Regional Ecological Observatories to evaluate deployment criteria and locations across the continental US, Alaska, Hawaii, and Puerto Rico and to form the collaborations, partnerships, and organizations needed for NEON infrastructure deployment.

In FY 2006, NEON funding will be provided for the Cyberinfrastructure for Environmental Observatories: Prototype Systems to Address Cross-Cutting Needs competition to stimulate interdisciplinary collaborations that result in the development and deployment of viable prototype cyberinfrastructure for environmental observatories. The resulting awards will expand NEON research and development to include a cyberinfrastructure research program to address interoperability with other networks and observing systems.

In FY 2007, an award will be made to complete the final Project Execution Plan for NEON, finalize deployment, and conduct (as appropriate) EIA/EIS. MREFC funds are requested for the construction and evaluation of the NEON fundamental technology unit. During FY 2007, the NEON research and development program will emphasize environmental sensors and networks to address interoperability and enabling technologies for ecological forecasting.

Major milestones for NEON are listed below.

FY 2005 Milestones:
- NEON Design Consortium and Project Office established
- NEON Advisory Board and Design Consortium subcommittees appointed
- NEON science requirements, facilities and infrastructure reference design refined, and the governance and management structures for NEON developed
- Research and development projects on environmental sensors, networks, and cyber tools that will advance the development of NEON as a network of nationally deployed infrastructure funded

FY 2006 Milestones:
- NEON Inc. established
- Review of NEON Science Plan and Requirements completed
- Baseline Networking and Informatics Plan and an external design review completed
- NEON Conceptual Design, Preliminary Project Execution Plan, and Project Development Plan completed
- NEON research infrastructure baseline design review and external cost review conducted
- Management review of the NEON Design Consortium and Project Office
- Research and development of cyberinfrastructure to address interoperability with other environmental networks and observing systems funded

FY 2007 Milestones:
- Final Project Execution Plan
- Baseline NEON Infrastructure design, cost, and management reviews
- NEON fundamental technology unit (BioMesoNet, sensor micronets, and enabling cyberinfrastructure) assembled and field-tested
- NEON infrastructure deployment plan finalized
- Environmental Impact Assessment and/or Environmental Impact Statements (EIA/EIS), if appropriate, will be conducted
- Additional research and development on environmental sensors and sensor networks and enabling technologies for ecological forecasting

FY 2008 – FY 2011 Milestones:
- Construction of NEON research, networking, informatics, and education, training and outreach infrastructure begins
- Research and development activities on environmental sensors, networks, cyber tools for NEON, and interoperability with other networks and observing systems continues

<u>Funding Profile</u>: NSF expects to spend approximately $18 million in concept and development activities through FY 2006. The current construction costs for NEON are being revised based on deploying NEON simultaneously as a national research platform (NRC 2004). Total construction costs for NEON will be

determined from the project execution plan developed for research, networking, and education infrastructure due June 1, 2006. Management, operations, and maintenance will be funded through the R&RA Account. After a thorough cost review, a revised budget for NEON infrastructure and maintenance and operations will be provided.

Requested MREFC Funds for NEON
(Dollars in Millions)

FY 2007 Request	FY 2008	FY 2009	FY 2010	FY 2011	Total
$12.00	$12.00	$20.00	$30.00	$26.00	$100.00

NEON Funding Profile
(Obligated Dollars and Estimates 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 & Earlier	0.31						$0.31	-	**$0.31**
FY 2002	1.00						$1.00	-	**$1.00**
FY 2003	0.92						$0.92	-	**$0.92**
FY 2004	3.60						$3.60	-	**$3.60**
FY 2005	5.98						$5.98	-	**$5.98**
FY 2006 Current Plan	5.94						$5.94	-	**$5.94**
FY 2007 Request	11.94			12.00			$11.94	$12.00	**$23.94**
FY 2008 Estimate	10.00			12.00	4.80		$14.80	$12.00	**$26.80**
FY 2009 Estimate	8.00			20.00	8.80		$16.80	$20.00	**$36.80**
FY 2010 Estimate	6.00			30.00	14.80		$20.80	$30.00	**$50.80**
FY 2011 Estimate	4.00			26.00	28.00		$32.00	$26.00	**$58.00**
FY 2012 Estimate	2.00				28.70		$30.70	-	**$30.70**
Subtotal, R&RA	$59.69		-		$85.10		$144.79		
Subtotal, MREFC		-		$100.00		-		$100.00	
Total, Each Stage		**$59.69**		**$100.00**		**$85.10**			**$244.79**

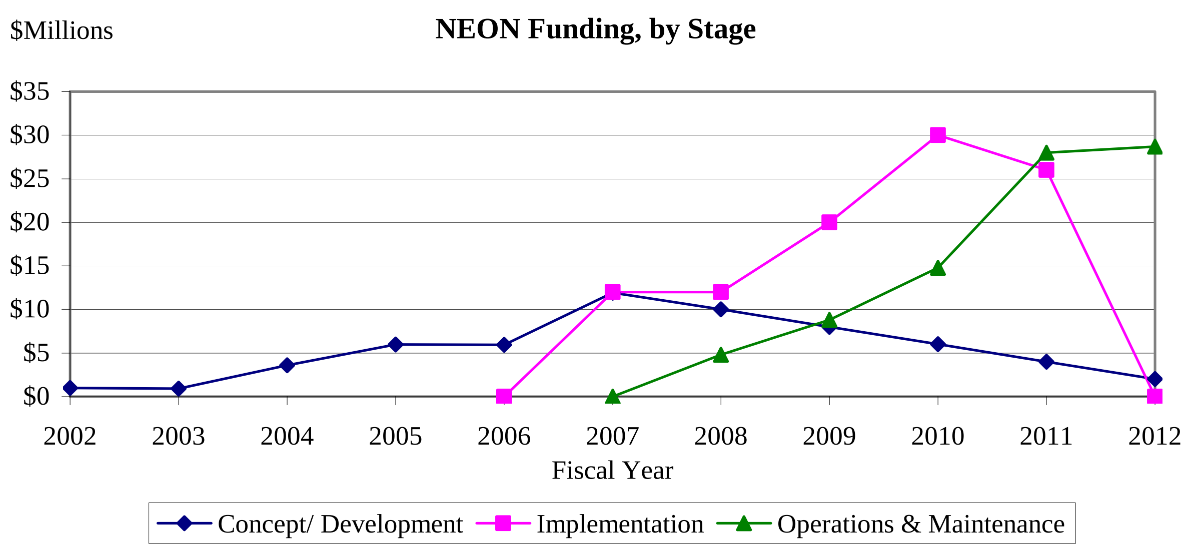
NOTE: The expected operational lifespan of this project is 30 years after construction is complete. Implementation funding levels will be updated based on the cost review of the Project Execution Plans (PEP) for research infrastructure, networking and informatics, and education, outreach, and training. Annual operations and maintenance estimates for FY 2008 and beyond are presented strictly for planning purposes and are calculated as 28 percent of the pre-PEP, estimated MREFC costs summed to that year. They will be updated when the implementation costs are updated and reviewed.

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

- Concept/Development: In FY 2003, the National Research Council's study on NEON recommended that the infrastructural elements needed to address the six greatest ecological research challenges be simultaneously deployed across the US and that a central NEON governance structure be established. A redefinition of an earlier scope, schedule, and cost for NEON was required in light of these recommendations. In FY 2004 and FY 2005, an award was made for a NEON Design Consortium and Project Office to redefine NEON (science and education plan and reference design) and to develop the preliminary project execution plan for simultaneous national deployment. In FY 2006, support led to completion of the NEON Science Plan and Requirements and the Networking and Informatics Plan. Review of the preliminary Project Execution Plan is scheduled. Support will be continued for research and development of NEON enabling technologies from FY 2006 through the construction phase.

- Implementation: Total construction costs for NEON will be determined from the project execution plan developed for research, networking, and education infrastructure due June 1, 2006. After a thorough cost review, a revised budget for NEON infrastructure and maintenance and operations will be provided. NEON will include the standardized technology deployed across the U.S. and connected via cyberinfrastructure into a national research platform. In FY 2007, MREFC funds will be used to assemble and evaluate the NEON fundamental technology unit (BioMesoNet, sensor micronets, and enabling cyberinfrastructure) that will be deployed.

- Operations and Maintenance: Initial operations support will begin in FY 2008 as construction is commenced on NEON networking, and informatics infrastructure. Operations and maintenance support will increase as NEON is brought online.

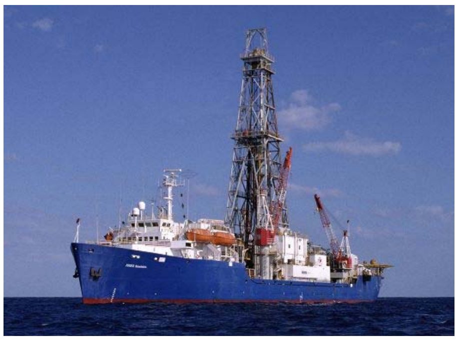


<u>Future Science Support</u>: Since NSF supports 63 percent of the fundamental ecological research performed at U.S. academic institutions, advances in the field of ecology, and the infrastructure to enable those advances, depend largely on support from NSF. Current research infrastructure is inadequate to enable studies to address the complex phenomena driving ecological change in real time and at the appropriate scales. As a continent-wide research instrument, NEON could. 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 annually.

NEON will support a large and diverse group of organizations and individuals; foremost are the scientists, educators, and engineers who will utilize NEON infrastructure in their research and educational programs. NEON will provide enhanced research opportunities for existing field-based research networks, using natural history collections, and the cyberinfrastructure communities that are facilitating network-level ecological science. As a cyberinfrastructure enabled network, NEON will be accessible to academic and research institutions, state and federal research and management organizations, minority serving institutions, community colleges, K-12 school systems, the general public, natural resource and conservation organizations, and other public and private organizations. Thousands of researchers will be able to use NEON, tens of thousands of children may participate in NEON activities through its educational programs, and hundreds of thousands of individuals will be able to access NEON data, information and research products via 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. The proposed Scientific Ocean Drilling Vessel (SODV) 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 U.S. facility contribution to the Integrated Ocean Drilling Program (IODP), which began on 1 October 2003. The IODP is co-led by the NSF and the Ministry of Education, Culture, Sport, Science and Technology (MEXT) of Japan. European and Asian nations are also participating in the program.



Pictured above is the *JOIDES Resolution*, the current drillship of the ODP. NSF will modify this or a similar ship to provide the IODP with light drillship capability. *Credit: 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 manager receives advice and oversight support from a NSF Project Advisory Team, which consists of representatives from GEO, 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 provides advice and assistance. A SODV Independent Oversight Committee (SIOC) has been established to provide technical, financial and scheduling recommendations and advice for the SODV project to top-level management. Also, a Program Advisory Committee (PAC), composed of members of the science and drilling communities, will provide an ongoing assessment of design plans for the on-board science and drilling capabilities and will ensure that the final plans reflect the needs of the scientific communities.

Current Project Status: In September 2003, NSF awarded a contract to Joint Oceanographic Institutions, Inc. (JOI) for IODP drilling operations, which included as one task the planning and implementation of the SODV project. JOI issued an RFP to acquire, upgrade and operate a commercial vessel for scientific ocean drilling. The contract was awarded to Overseas Drilling Limited in December 2005. The SODV Project received $14.88 million in FY 2005, with $57.24 million appropriated in FY 2006. Engineering design and science lab development activities are currently underway. The project schedule is outlined below:

FY 2005 Milestones:

Release RFP for SODV Drilling Contractor and Evaluate Responses (Completed)

Determine Competitive Range of Offerors – Initiate SODV MREFC project (Completed)

FY 2006 Milestones:
- Vessel Decision and Drilling Contractor Award (Completed)
- Initiate Engineering Design Phase, including Science Lab Development (Completed)
- Initiate Long Lead Item Equipment Procurement
- Complete Engineering Design Phase
- Issue Drilling Contractor Solicitation for Conversion Shipyard
- Shipyard Contract Award
- Initiate Shipyard Conversion of Drillship

FY 2007 Milestones:
- Complete Equipment/Structural Removals
- Develop Production Engineering Package
- Install Habitability and Science Modules
- Outfit Scientific Laboratories
- Vessel Acceptance Trials
- Vessel Commissioning and Acceptance –Terminate SODV MREFC project
- Vessel Scientific Operations Begin

Funding Profile: Planning through FY 2005 cost approximately $4.7 million. In FY 2005, approximately $6.08 million was awarded to initiate contract activity, planning and design. In FY 2005 - FY 2007, approximately $109.0 million of funds from the MREFC account will be required for conversion/equipping/testing of the drillship.

Appropriated and Requested Funds for SODV
(Dollars in Millions)

	FY 2005	FY 2006	FY 2007	Total
SODV	$14.88	$53.09	$42.88	$110.85
Unobligated Balance from FY 2005		$4.14		$4.14
Total, SODV	$14.88	$57.24	$42.88	$115.00

SODV Funding Profile

(Obligated Dollars and Estimates in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		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	1.50						$1.50	-	$1.50
FY 2004	2.10						$2.10	-	$2.10
FY 2005	0.50			6.08			$0.50	$6.08	$6.58
FY 2006 Current Plan				66.04			-	$66.04	$66.04
FY 2007 Request				42.88	21.30		$21.30	$42.88	$64.18
FY 2008 Estimate					57.00		$57.00	-	$57.00
FY 2009 Estimate					58.60		$58.60	-	$58.60
FY 2010 Estimate					60.70		$60.70	-	$60.70
FY 2011 Estimate					62.00		$62.00	-	$62.00
FY 2012 Estimate					64.00		$64.00	-	$64.00
Subtotal, R&RA	$4.70		-		$323.60		$328.30		
Subtotal, MREFC		-		$115.00		-		$115.00	
Total, Each Stage		$4.70		$115.00		$323.60			$443.30

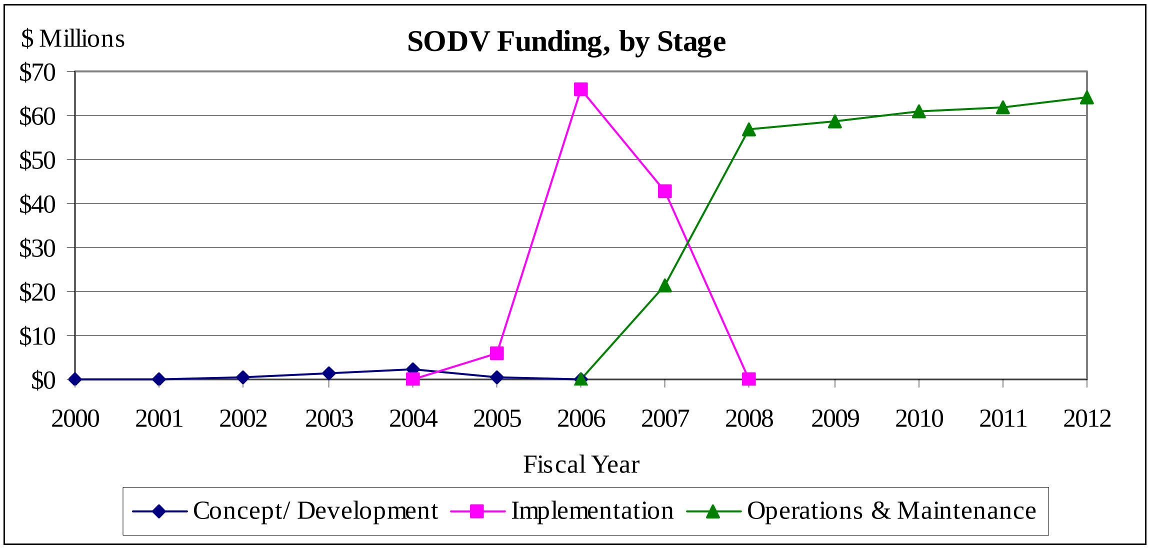
A steady state of about $57 million in operations support is expected to occur beginning in FY 2008 as the SODV vessel begins full operations, but these estimates are developed based on current cost profiles and will be updated as new information becomes available. The expected operational lifespan of this project is 15 years, beginning in FY 2007.

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

- Concept/Development: Activities supported by the R&RA account included coordination and planning efforts necessary for SODV planning with Japanese partners and the scientific user community; development of the SODV Project Execution Plan by the contractor; scoping of the environmental requirements, and permitting issues for the SODV drilling vessel..

- Implementation: The MREFC funds in FY 2005-07 are required for the engineering design and vessel conversion, including construction of laboratory and other scientific spaces, equipping of laboratories with instrumentation, computers and support equipment, upgrade of the accommodations spaces and modifications to the drilling equipment of the contracted vessel. Funding is also required for vessel lease during modification and for sea-trial operations in FY 2007.

- 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, and the contract with the SODV operator. 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 are occurring with Japanese operators of their drillship in the IODP.



<u>Future Science Support</u>: 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 $30 million.

South Pole Station Modernization (SPSM)

Project Description: South Pole Station Modernization (SPSM) provides a new station to replace the current U.S. station at the South Pole, built 30 years ago and inadequate in terms of capacity, efficiency, and safety. The new station is 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 accordance with U.S. policy.

Principal Education Goals: Support education associated with the research projects at the South Pole.

Connections to Industry: There are approximately 385 separate subcontractors for supplies and technical services. The U.S. Antarctic Program prime support contractor is Raytheon Polar Services Company (RPSC).

Management and Oversight: The Office of Polar Programs (OPP) has the overall oversight 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 staff and the project's PAT. The NSF Deputy Director for Large Facility Projects regularly briefs the Chief Financial Officer and the NSF Director on project status.

Aurora Australis – the Southern lights, over the National Science Foundation's (NSF) Amundsen-Scott South Pole Station. This image shows the atmospheric phenomenon over a wing of the new station that NSF is building. *Credit: USAP*

Current Project Status: The original estimate for SPSM was $127.90 million. In 2001, the NSB approved a change in project scope, increasing station capacity from 110 people to 150 people, as well as a project schedule extension caused almost entirely by weather-imposed logistics delays, increasing the cost estimate to $133.44 million. The estimated projection had been for conditional acceptance (i.e., occupation and operations) of the entire station by the end of FY 2007, with some work on punchlist items possibly occurring in FY 2008. Although no funds were requested for SPSM in the FY 2006 Budget Request to Congress, the update in the Request on SPSM indicated that the cost-to-complete at the time of budget submission was $136.96 million. The Budget Request also indicated "an updated project cost and schedule review will be completed shortly after the end of the 2004/2005 operating season." That review has now been completed and has been reviewed by the SPSM Project Advisory Team and OPP management. At the end of the 2004/2005 season, the delivery of project material was 4.3 million pounds behind schedule. This delay has resulted in the station's completion being moved at least to FY 2008, rather than FY 2007 as previously estimated. There is some possibility that final completion will be further delayed, perhaps in order to accommodate logistics support for high priority science projects at South Pole Station. Such delay would not impact full use of planned station facilities and is unlikely to cause significant cost increases. The new "cost to complete" total for the project is $142.71 million. Total funding for SPSM through FY 2006 is $133.51 million; the amount of additional funding required to complete the project is $9.13 million.

These are the current milestones.

Activity	Procurement	Transport to Antarctica	Airlift to South Pole	Start Construction	Conditional Acceptance
Vertical Circular Tower	FY98	FY99	FY99/00	FY00	FY02
Quarters/Galley	FY98	FY99	FY00/FY01	FY01	FY03
Sewer Outfall	FY98	FY99	FY00	FY01	FY02
Fuel Storage (100K gallons)	FY98	FY98	FY99	FY99	FY99
Medical/Science	FY99	FY00	FY01/02	FY02	FY04
Communications/Administration	FY99	FY01	FY02/03	FY03	FY06
Dark Sector Lab	FY98	FY99	FY99/00	FY00	FY06
Water Well	FY00	FY01	FY01/02	FY02	FY07
Remote RF Building	FY99	FY00	FY01	FY01	FY01
Emergency Power/Quarters	FY99	FY01	FY02/03	FY03	FY05
Liquid nitrogen and helium facility	FY02	FY03	FY04	FY04	FY07
Quarters/Multipurpose	FY99	FY02	FY04	FY05	FY06
Electronic Systems and Communications	FY00/03	FY01/04	FY01/05	FY01	FY06
Warehousing, SEH and Waste Management	FY99	FY02/03	FY04/05/06	FY07	FY08
Station Equipment	FY02/03	FY03/04	FY04/05	N/A	FY08

Funding Profile: SPSM funding totals $133.51 million through FY 2006, exceeding the most recent NSB-approved cost estimate of $133.44 million. Based on an updated project cost and schedule review completed after the 2004/2005 operating season, the estimated total cost to complete SPSM is $142.71 million.

Appropriated and Requested MREFC Funds for SPSM

(Dollars in Millions)

	FY 98	FY 99	FY 00	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 2007 Request	Total
SPSM Appropriations	70.00	39.00	5.40	13.47	-	5.96	1.29	-	-	9.13	144.25
Reprogramming				-1.00	-0.50	-0.24			0.12		-1.62
	$70.00	$39.00	$5.40	$12.47	-$0.50	$5.73	$1.29	-	$0.12	$9.13	$142.64

NSF reprogrammed $1.0 million in FY 2001 to the Polar Support Aircraft Upgrades, $500,000 in FY 2002 to the South Pole Safety and Environment project, and $235,000 in FY 2003 to HIAPER and LHC to cover final costs due to a recission in that year. The FY 2004 appropriation for SPSM represents payback for the reprogrammings in FY 2001 and FY 2003. SPSM received $120,000 of available funds in FY 2006 from the Polar Aircraft Support Upgrades upon completion of that project.

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 the 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. SPSM obligations total $120.41 million through FY 2005.

South Pole Station Modernization Funding Profile

(Obligated Dollars and Estimates in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		**Grand**
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	**Total**
FY 1997 & Earlier	16.40						$16.40	-	$16.40
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				21.02			-	$21.02	$21.02
FY 2005				16.86			-	$16.86	$16.86
FY 2006 Current Plan				8.59			-	$8.59	$8.59
FY 2007 Request				9.13	15.00		$15.00	$9.13	$24.13
FY 2008 Estimate				4.51	15.38		$15.38	$4.51	$19.89
FY 2009 Estimate					15.76		$15.76	-	$15.76
FY 2010 Estimate					16.14		$16.14	-	$16.14
FY 2011 Estimate					16.53		$16.53	-	$16.53
FY 2012 Estimate					16.94		$16.94	-	$16.94
Subtotal, R&RA	$16.40		-		$95.74		$112.14		
Subtotal, MREFC		-		$142.64		-		$142.64	
Total, Each Stage		$16.40		$142.64		$95.74			$254.78

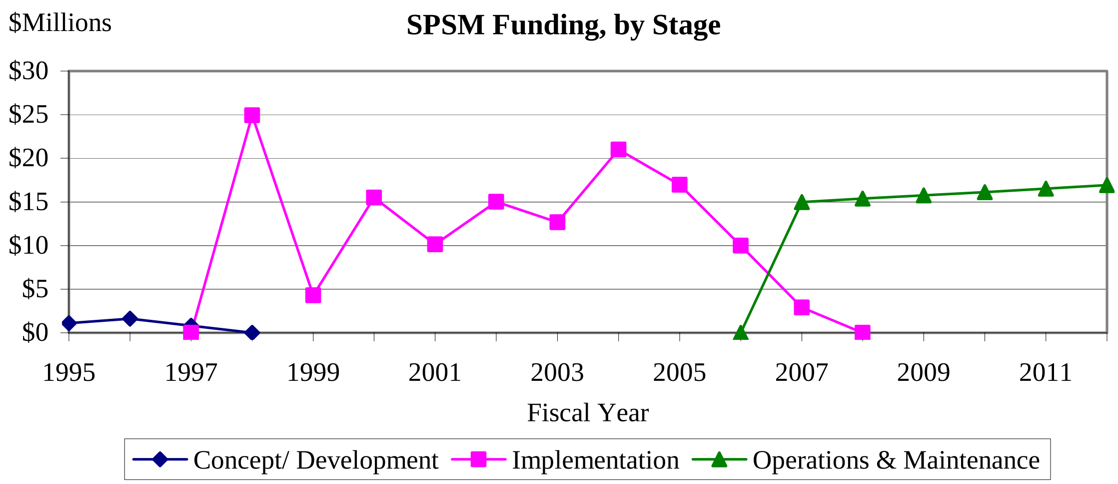
NOTE: A steady state of operational support is anticipated at about $15 million by FY 2008, slightly higher than the current operational costs. The expected lifespan of the modernized station is 25 years, through FY 2031. Operations estimates for FY 2008 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

Information 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.

- 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 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 $8.0 million.

Department of Justice Settlement

Background: A project was initiated in 1998 both to modify and to upgrade and maintain three NSF-owned LC-130s to meet Air Force safety and operability standards that differ from those of the previous U.S. Navy operators. Modifications specified by the Air Force included avionics, airframe, safety, propulsion, and record data; storage and project administration costs were also included. Ski-equipped LC-130 aircraft are the backbone of the U.S. Antarctic Program's (USAP) air transport system and also support NSF's research in the Arctic. In FY 1998 $4.30 million from the Research and Related Activities (R&RA) account was provided for early engineering design, and between FY 1999 and FY 2002 $32.90 million from the Major Research Equipment and Facilities Construction (MREFC) account was expended for the modifications. The work included scheduled maintenance requirements.

Project Management: The contract for the modifications was awarded and administered by the Air Force C-130 Systems Program Office at Warner Robins Air Logistics Center (Warner Robins, GA; WRALC), which is the C-130 engineering authority for the Air Force. The solicitation also sought Programmed Depot Maintenance services in accordance with Air Force standard operating procedures. In March 1999, the Air Force awarded the contract for the work to Raytheon Services E-Systems. The contract was subsequently transferred to L-3 Communications, Inc. (L3) when it acquired Raytheon Services E-Systems.

The Warner Robins Air Logistics Center served as the procurement office with oversight and contract administration responsibilities. The contract was assigned for administration in accordance with FAR 42.202 to the Defense Contract Management Command, Dallas. NSF, responsible for the management of the USAP, served as the funding agency for the contract. To date, NSF has reimbursed WRALC for all its fees and costs relating to the performance and administration of the contract. The Defense Contracts Management Agency (DCMA) accepted the three aircraft on behalf of the Government.

Request for Equitable Adjustment: In June 2002, L3 Communications informed WRALC that it was experiencing substantial financial loss on the contract. In September 2002, L3 Communications indicated they would be submitting a request for equitable adjustment (REA) in the amount of $14.9 million. In January 2004 the contractor submitted a proposal to settle the REA in the amount of $2,999,941. In support of its proposal, the contractor submitted certified cost and pricing data for the proposed settlement amount.

Settlement Funding: In response to the contractor's settlement proposal, WRALC conducted a legal review and litigation risk assessment for the contractor's REA. It concluded that the Government was partly liable for L3 Communications' $14.9 million of uncompensated incurred costs based on the legal theories of defective specifications, mistake in bid caused by the Government providing late, defective, or unsuitable property, data and information, superior knowledge, constructive change, estoppel, detrimental reliance, and *quantum meruit* (i.e., "reasonable value of services"). The WRALC further concluded that the Government's litigation exposure came to about $7.5 million, including various fees and costs to litigate the matter. The WRALC recommended that the Government settle the matter for $3.0 million, as proposed by L3 Communications.

As a result of the WRALC legal review and litigation risk assessment, the Air Force and NSF discussed how the agencies would fund the costs to settle the REA submitted by L3 Communications or satisfy a judgment against the Government. Based on the facts provided by WRALC, NSF did not disagree with the Air Force's legal review and litigation risk assessment. Based on the review and assessment presented by WRALC, NSF agreed in principal that a settlement for $3.0 million in this case would best serve the interest of the Government.

In light of the Air Force's stated willingness to bear partial responsibility for the additional costs, NSF and WRALC officials, over the course of several months, endeavored to find a legal basis that would allow the Air Force to contribute funds to settle the contractor's REA. Based on an opinion issued by the Office of Legal Counsel in the Department of Justice, NSF advised the Air Force that a performing agency has the discretion to pay for actual costs, without seeking reimbursement from the ordering agency if the interagency agreement was based on authority other than the Economy Act.

On July 16, 2004, the Air Force informed NSF that under the Economy Act it was unable to use its appropriated funds to settle the REA even though NSF had relied on authorities other than the Economy Act when agreeing to fund the contract that Air Force would administer. It also notified NSF that "under the circumstances, we believe that referring the matter to the Department of Justice for an opinion would not be helpful." The Air Force did not articulate a policy, budgetary, or operational rationale for its decision.

Because the NSF lacked the necessary funding in its budget and the agencies had reached an impasse on whether the Air Force could contribute funds to the settlement, the Air Force denied the contractor's claim. L3 Communications appealed the agency's decision to the Armed Services Board of Contract Appeals (ASBCA). Pursuant to a settlement agreement, the Air Force agreed to pay the contractor $2,999,941 in return for L3 Communications agreeing to settle all present and future disputes, claims, and appeals, arising under or related to the contract. The ASBCA issued an opinion awarding the contractor $2,999,941 to be paid from the Judgment Fund, established under 31 U.S.C. § 1304.

<u>Current Status</u>: On March 15, 2005, the Judgment Fund Branch, Department of the Treasury, requested that the NSF reimburse the Judgment Fund for the settlement amount. The FY 2007 Budget Request of $3.0 million funds the necessary reimbursement to the Judgment Fund.

SECOND PRIORITY: NEW STARTS IN FY 2007 AND FY 2008

NSF's second priority are those projects that have received NSB-approval for inclusion in a budget request but which have not yet received funding. NSF is requesting funding for two new starts in FY 2007 and one new start in FY 2008. In priority order, these are:

- the Alaska Region Research Vessel in FY 2007,
- the Ocean Observatories Initiative in FY 2007, and
- Advanced LIGO in FY 2008.

Alaska Region Research Vessel

Project Description: The Alaska Region Research Vessel (ARRV) is proposed to replace the R/V *Alpha Helix*, which, at 40 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*, a restrictively small ship that cannot operate in ice or in severe winter weather in the open seas. The ARRV will operate year round in the challenging waters of the Chukchi, Beaufort, and Bering Seas, as well as the open Gulf of Alaska, coastal Southeast Alaska and Prince William Sound, including in seasonal ice.

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 (up to three feet thick) ice has become increasingly urgent. The ARRV will provide greatly improved access to the region, enabling further exploration to address critical issues. With an operating year of 275-300 days, the ARRV could accommodate upwards of 500 scientists and students at sea annually.

This image is an artist's rendition of the ARRV, proposed to replace the R/V *Alpha Helix*, which, at 39 years is the oldest ship in the national academic research fleet.

Principal Scientific Goals: Satellite observations have shown that the perennial ice in the arctic is thinning at a rate of 9 percent per decade, which is beginning to have major regional and global consequences. Research is urgently needed on topics ranging from climate change, ocean circulation, ecosystem studies and fisheries research to natural hazards and cultural anthropology. Most of these cutting edge science projects require a technologically advanced oceanographic platform in the Alaska region to conduct field research and long-term observations.

Principal Education Goals: The ARRV will provide a sophisticated and significantly larger platform for scientists, graduate and undergraduate students to participate in complex multidisciplinary research activities and will enable the training of the next generation scientists with the latest equipment and technology. Broadband satellite connections capable of relaying data including high definition video from tools such as remotely operated vehicles, which explore under the ice and 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 Director for Ship Acquisition and Upgrades, within the Integrative Programs Section (IPS) in the Division of Ocean Sciences (in GEO), with additional staff in IPS providing project management assistance. The Section Head (IPS) and another Section member hold the Master's Certificate in Project Management through NSF-sponsored training, and other members of the Division are in training. Internal oversight for the construction cooperative agreement will be provided by a Project Advisory Team (PAT) which includes staff from GEO, the Office of Budget, Finance, and Award Management (BFA), the Office of the General Counsel, and the NSF Deputy Director for Large Facility Projects. The Awardee will hire a Systems Integration

Manager to establish and staff an Office to provide a management team for 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 scientific outfitting of the vessel.

Current Project Status: Final model tank testing and data analysis were successfully completed in 2003. Results from model testing concluded that the current design has excellent sea keeping and enhanced icebreaking capabilities. In addition, acoustic testing demonstrated that the vessel will have sufficient "quieting" characteristics to support fisheries research. Results from the design studies have been shared with the community on many occasions during development, offering opportunities for interactive exchanges to take place between potential vessel users and the naval architects. Following minor design adjustments based upon these inputs, the design phase was completed in 2004. A meeting of the Oversight Committee and agency representatives held in December 2004 reviewed and accepted the final "contract design" document. This document provides the complete list of specifications and drawings from which a shipyard could make a construction bid. The next action will be for NSF to issue a competitive solicitation for a cooperative agreement for the construction and operation of this ship.

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, originally stated in the 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[7]. An update of this Plan will be published later this year.

Milestones for ARRV are outlined below:

FY 2006 Milestones:
- Prepare and issue a solicitation to build and operate the ARRV via a Cooperative Agreement.
- Complete an external merit review process of proposals received.

FY 2007 Milestones:
- Negotiate a Cooperative Agreement with the selected institution.
- Awardee establishes the Project Management Office and issues the shipyard construction bid package.
- Awardee reviews ship construction bids and prepares a contract with the successful bidder.
- Vessel construction is initiated.

FY 2008 Milestones:
- Vessel construction continues.
- Monthly and in-depth quarterly reviews with NSF oversight, to include on site inspections.
- Launch vessel.

FY 2009 Milestones:
- Complete vessel construction and outfitting.
- Undergo sea trials.
- Finalize acceptance and delivery of vessel to operating institution.
- Incorporate vessel into the UNOLS ship scheduling process.

[7] This report is available online: http://www.geo-prose.com/projects/fleet_rpt_2.html

FY 2010 Milestones:

Begin operations on NSF and other agency funded scientific missions.
NSF conducts final review of project.

Funding Profile: Recognizing from the outset of operations in Alaskan waters in 1980 that the R/V *Alpha Helix* was of marginal size and capability for the region, replacement planning has been ongoing since that time. NSF funded design studies in 1980 and 1995, but neither were implemented. Following a renewed effort by the user community through UNOLS to develop forward looking science mission requirements in 1999, NSF has since funded the concept design, detailed design and model testing for a replacement vessel and is prepared to initiate a two-year construction phase.

Requested MREFC Funds for ARRV
(Dollars in Millions)

FY 2007 Request	FY 2008	Total
$56.00	$42.00	$98.00

ARRV Funding Profile
(Obligated Dollars and Estimates in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		**Grand**
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	**Total**
FY 2003 & Earlier	1.61						$1.61	-	$1.61
FY 2004	0.30						$0.30	-	$0.30
FY 2005 Actual	0.30						$0.30	-	$0.30
FY 2006 Current Plan	0.10						$0.10	-	$0.10
FY 2007 Request				56.00			-	$56.00	$56.00
FY 2008 Estimate				42.00			-	$42.00	$42.00
FY 2009 Estimate					3.50		$3.50	-	$3.50
FY 2010 Estimate					7.00		$7.00	-	$7.00
FY 2011 Estimate					7.50		$7.50	-	$7.50
FY 2012 Estimate					8.00		$8.00	-	$8.00
Subtotal, R&RA	$2.31		-		$26.00		$28.31		
Subtotal, MREFC		-		$98.00		-		$98.00	
Total, Each Stage		$2.31		$98.00		$26.00			$126.31

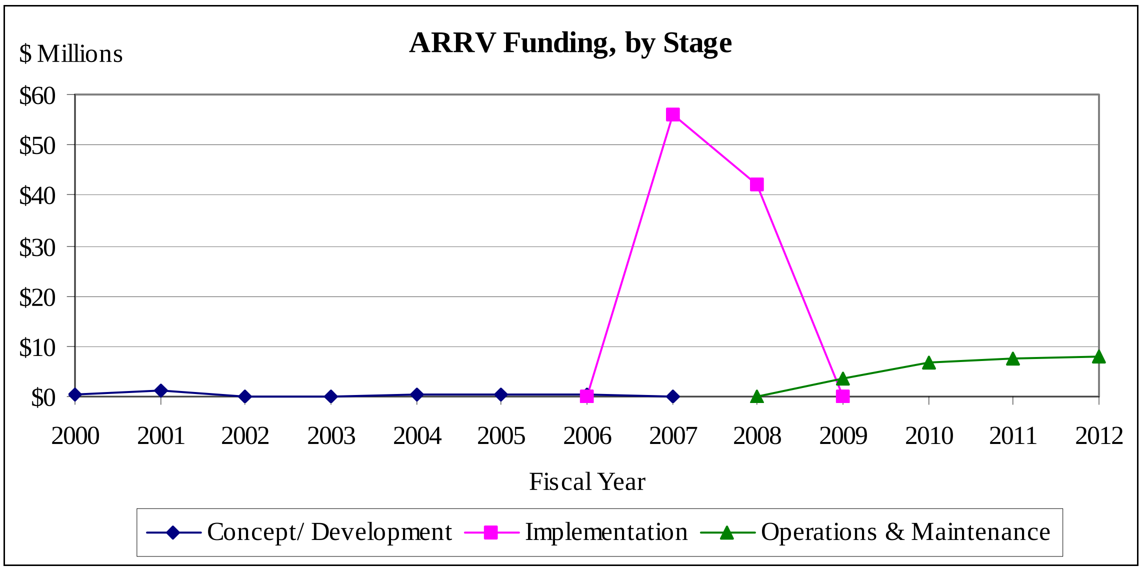
Ship operations are estimated to be approximately $7 million for the first full year. The expected operational service life of the ARRV is 30 years after construction is complete. Operations estimates for FY 2011 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

Information on the data in the table is provided below.

- Concept/Development: 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.

- Implementation: The project will be prepared to go into the construction phase in FY 2007. It is anticipated that the vessel will be constructed over a two-year period and will be ready for sea trials and commissioning. It will be ready to conduct science activities within two and a half years after construction is initiated.

- Operations and Maintenance: 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 (UNOLS) process, which will allow NSF and other agency funded scientists access to the vessel to conduct research and train students. The initial annual ship operation costs are estimated to be about $7 million.

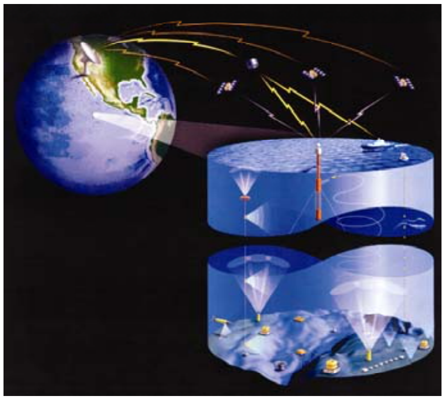


<u>Future Science Support</u>: Along with direct operations and maintenance support for the ARRV as part of the Academic Research Fleet, NSF will support research performed using this platform through ongoing research and education programs. It is anticipated that the ARRV will greatly expand research capabilities in the region, going from a maximum of 160 ship operating days with the R/V *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. The International Polar Year will undoubtedly stimulate new interest in expanded research in the region. Indeed, the fact that construction of the ARRV has been widely anticipated over the past several years, has led to a temporary, but greatly reduced rate of submission of proposals to utilize the R/V *Alpha Helix*, because the community would vastly prefer to mount future multidisciplinary oceanographic cruises on the ARRV, with its greatly increased size, range, accommodations, habitablilty and ice capability.

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, interactive access to the ocean. The OOI will have three elements: 1) a global-scale array of relocatable deep-sea buoys, 2) a regional-scaled cabled network consisting of interconnected sites on the seafloor spanning several geological and oceanographic features and processes, 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.

Principal Scientific Goals: Scientific problems requiring OOI infrastructure are broad in scope and encompass nearly every area of ocean science. Once established, seafloor observatories will provide earth, atmospheric, 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. OOI facilities will meet the following goals: continuous observations 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 for interactive experimentation; an ability to operate during storms and in harsh conditions; an ability to easily connect 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.



This image is an artist's rendition depicting the OOI, which portrays the seafloor junction boxes, the bouys and the cable network. OOI is expected to transform the way we observe the ocean environment.

Principal Education Goals: 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 the Division of Ocean Science's (OCE's) Centers for Ocean Science Education Excellence (COSEE). In addition, with the planned establishment of the National Integrated Ocean Observing System (IOOS), 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.

Partnerships and Connections to Industry: 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.

Management and Oversight: The project is managed and overseen by a program manager in OCE (in GEO). The program manager receives advice and oversight support from an NSF Project Advisory Team (PAT) that includes representatives from GEO, Biological Sciences, Engineering; 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 provides advice and assistance. The management structure proposed for the construction 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 OOI Project Director operating from the Ocean Observatory Project Office established through a cooperative agreement with NSF in 2004. This Project Director will be accountable to an Executive Steering Committee under which will be established scientific and technical advisory committees. Advisory committee membership will be drawn from individuals with expertise in ocean observing science and engineering. During the construction phase, Implementing Organizations (IOs) contracted by the Project Office will provide the detailed management and oversight for implementation of the three OOI elements as well as the project's cyberinfrastructure. These IOs will report directly to the Project Office. The OOI will be coordinated with the IOOS that will support operational mission objectives of agencies such as the National Oceanic and Atmospheric Administration, the Navy, the National Aeronautics and Space Administration, and the Coast Guard.

Current Project Status: Numerous community workshops have been held and reports written since 2000. These activities helped define the scientific rationale, determine the technical feasibility, and develop initial implementation plans for the OOI. These include two NRC reports as well as two community reports for each of the three OOI components. These planning activities were followed by a large, multi-disciplinary workshop held in January 2004 to develop an initial science plan for the OOI across coastal, regional, and global scales. The Ocean Observatory Project Office has been established and tasked to continue refinement of the OOI network design with advice from the research community; to develop a consensus vision for the OOI organizational structure, governance, and operating plans; to identify and engage all constituencies of the ocean science research community in consensus-building activities; and to operate an interactive web site for communicating with the ocean science community in regard to OOI activities and planning. The Project Office has established an advisory structure that provides a direct link between Project Office planning and the research community.

To continue community planning for OOI implementation, detailed conceptual proposals for ocean science research experiments were solicited through the Ocean Observatories Project Office. These proposals were peer reviewed and are now being used to further refine designs for the OOI and to identify specific experimental instrumentation needs of the user community. This process will help refine cost estimates for ocean observatory science and enabling infrastructure to be constructed though the OOI. The initial implementation plan arising from this exercise will be reviewed and discussed at the March 2006 OOI Design and Implementation workshop whose aim is to provide the community with a final opportunity to iterate these plans prior to the Construction Phase. Using R&RA funds, the Ocean Technology and Interdisciplinary Coordination Program has continued to provide support for proposals whose goals are to ensure that infrastructure needed to enable OOI experimentation is available for the implementation phase of the OOI.

The construction schedule for this project is still under review and therefore the milestones listed below will likely be revised as the project's schedule is finalized.

FY 2006 Milestones:
- Review of Internal Management Plan by Facilities Panel
- Completion of Project Development Plan
- OOI Conceptual Design Review
- Complete design of data management and archiving system
- Completion of OOI Project Execution Plan
- Selection of Implementing Organizations
- Initiate EA/EIS and permitting process

FY 2007 Milestones:
- Submission of Project Execution Plan to Large Facilities Office
- OOI Preliminary Design Review/Final Design Review
- Initial implementation of data management and archiving system
- EA/EIS and permitting
- Staffing up of Implementing Organizations
- Coastal Observatories
- Site surveys

FY 2008 Milestones:
- First Phase of the global array
- First Phase of the coastal array
- Shore station construction for the RCO
- RCO cable route surveys
- EA/EIS permitting process for the RCO cable route

FY 2009 Milestones:
- Regional Cabled Network
- Initial installation and inspection of cable backbone section
- Initial installation of science nodes and instrumentation on backbone section

FY 2010 Milestones:
- Regional Cabled Network
- Final installation and inspection of cable backbone section
- Final installation of science nodes and instrumentation on backbone section

FY 2011 Milestones:
- Second phase of the global array
- Second phase of the coastal array
- Initial commissioning and testing of the RCO

FY 2012 Milestones:
- Second phase of the global array
- Second phase of the coastal array
- Final commissioning and testing activities for the RCO

<u>Funding Profile</u>: NSF expects to spend approximately $52 million in concept and development activities through FY 2007. The total construction cost for OOI is $309.50 million beginning in FY 2007. These cost estimates have increased since the program was first proposed in response to increased deployment costs due to rising fuel costs and vessel operation costs (averaging 13% per year for recent years) and

increases in the costs estimated for OOI cyberinfrastructure. Management, operations and maintenance will be funded through the R&RA account.

Requested MREFC Funds for OOI
(Dollars in Millions)

FY 2007 Request	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	Total
$13.50	$48.00	$77.00	$78.00	$53.00	$40.00	$309.50

OOI Funding Profile
(Obligated Dollars and Estimates in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		Grand Total
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	
FY 2004 & Earlier	35.72						$35.72	-	$35.72
FY 2005	3.20						$3.20	-	$3.20
FY 2006 Current Plan	5.20						$5.20	-	$5.20
FY 2007 Request	8.30			13.50			$8.30	$13.50	$21.80
FY 2008 Estimate				48.00	3.00		$3.00	$48.00	$51.00
FY 2009 Estimate				77.00	7.00		$7.00	$77.00	$84.00
FY 2010 Estimate				78.00	12.00		$12.00	$78.00	$90.00
FY 2011 Estimate				53.00	25.00		$25.00	$53.00	$78.00
FY 2012 Estimate				40.00	40.00		$40.00	$40.00	$80.00
FY 2013 Estimate					50.00		$50.00	-	$50.00
FY 2014 Estimate					50.00		$50.00	-	$50.00
Subtotal, R&RA	$52.42		-		$187.00		$239.42		
Subtotal, MREFC		-		$309.50		-		$309.50	
Total, Each Stage		$52.42		$309.50		$187.00			$548.92

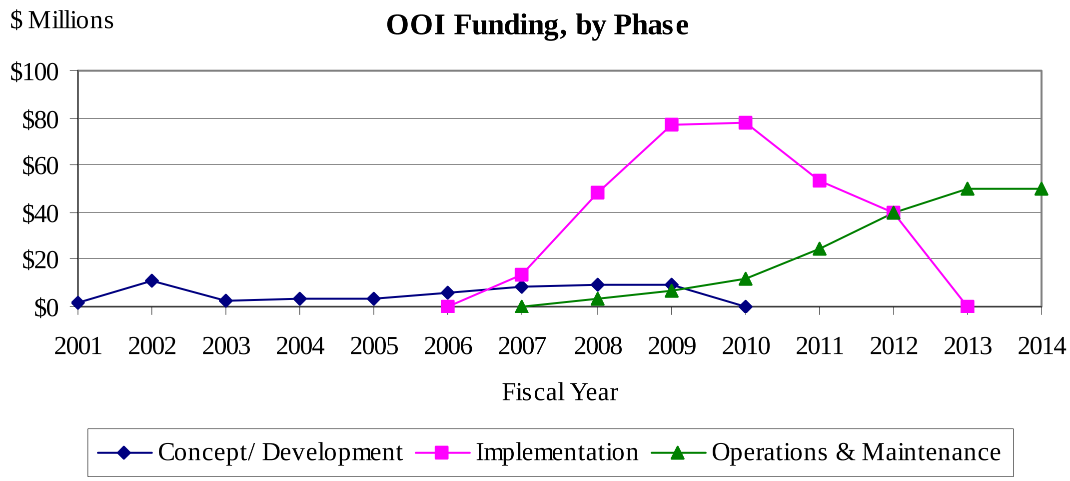
NOTE: A steady state of about $50.0 million in operations support is expected to occur in or about FY 2013. The expected operational lifespan of this project is 30 years, beginning in FY 2011. Operations estimates for FY 2008 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

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

- Concept/Development: R&RA funding has supported workshops to identify the observatory infrastructure needed to address the high priority science requiring time-series measurements as well as development efforts to advance observing technologies. Specific design characteristics and platform requirements were developed through conceptual design reviews and best practices consultations with industry and academic experts. The Monterey Bay Aquarium Research Institute has been awarded $11.60 million to establish an advanced cabled observatory in Monterey Bay. This observatory will advance scientific goals as well as create a systems and instrumentation testbed for potential future cabled ocean observing systems. R&RA funds are also being used to support the Ocean Observatories Project Office, advisory committees, and the implementing organizations.

- Implementation: Funds requested for this phase will construct a regional cabled observatory network spanning several geological and oceanographic features and processes; several relocatable deep-sea buoys to investigate global-scale processes; and new construction or enhancements to existing facilities leading to an expanded network of coastal observatories.

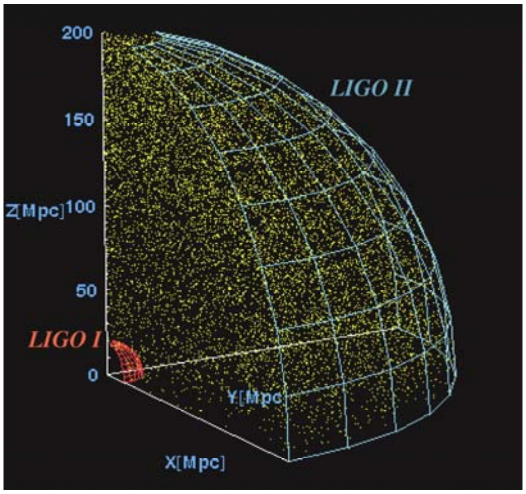
- Operations and Maintenance: Access to OOI Infrastructure will be determined by peer review and all data will be openly accessible. OOI Infrastructure will be maintained and operated by the Ocean Observatories Project Office. Future development of more complex sensor packages for the OOI infrastructure 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 million, once the network is fully implemented.

Advanced Laser Interferometer Gravitational Wave Observatory (AdvLIGO)

Project Description: Advanced LIGO is the upgrade of the Laser Interferometer Gravitational Wave Observatory (LIGO) that will allow LIGO to approach the ground-based limit of gravitational wave detection. LIGO consists of the world's most sophisticated optical interferometers, operating at two sites (Hanford, WA and Livingston, LA). Each interferometer has two 4-km arms at 90 degrees to one another. In addition, the interferometer at Hanford contains a 2-km interferometer within the same vacuum enclosure used for the 4-km interferometer. These interferometers are designed to measure the changes in arm lengths resulting from the wave-like distortions of space-time caused by the passage of gravitational waves. The changes in arm length that can be detected by the present Phase I LIGO are a thousand times smaller than the diameter of a proton over the 4-km arm length. AdvLIGO is expected to be at least 10 times more sensitive. The frequency range for which LIGO and AdvLIGO are designed will be sensitive to many of the most interesting cataclysmic cosmic phenomena believed to occur in the universe. Furthermore, because LIGO and AdvLIGO will push the sensitivity of gravitational wave detection orders-of-magnitude beyond existing frontiers, the potential for making discoveries of completely new phenomena is significant. LIGO will achieve its objectives as planned and may detect the first gravitational waves. AdvLIGO will greatly increase the sensitivity to ensure the detection of gravitational waves and to launch the new field of gravitational-wave astronomy.



The MREFC Project Advanced LIGO will improve the sensitivity of LIGO by more than a factor of 10, which will expand the volume of space LIGO will be able to "see" by more than 1,000.

The LIGO project was planned in two phases from the very beginning. Phase I would produce a gravitational wave detector that would be as sensitive as possible with the technology available in the early 1990s on a platform that could be upgraded to the ultimate sensitivity as the critical technologies were further developed. The goal of Phase I was to obtain a year's worth of accumulated data at the design sensitivity for Phase I (expressed as a dimensionless strain $h \sim 10^{-21}$, the ratio of the change in arm length to the length of the arm). The LIGO Laboratory expects to have those data in 2006-2007. The second phase, or AdvLIGO project, will upgrade LIGO to enable attainment of the ultimate sensitivity of an Earth-based gravitational wave observatory, limited only by the irreducible effects of fluctuations in the Earth's gravitational field. From the outset, the overall LIGO strategy was to produce a broadband gravitational wave detector with an unprecedented astronomical reach and then to upgrade the initial facility to achieve the most sensitive gravitational wave detector possible on Earth.

The LIGO program has strongly stimulated the interest in gravitational-wave research around the world, producing very vigorous programs in other countries that provide strong competition as well as highly beneficial collaborations. LIGO has pioneered the field of gravitational-wave measurement, and a timely upgrade is necessary to reap the fruits of this bold initiative. International partners are contributing significant human and financial resources.

Principal Scientific Goals: 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. Furthermore, even though the universe is believed to be filled with gravitational waves from a host of cataclysmic cosmic phenomena, scientists have never directly detected a gravitational wave and measured its waveform.

The principal scientific goals of the LIGO – AdvLIGO project are to detect gravitational waves on Earth for the first time and to develop this capability into gravitational wave astronomy — a new window on the universe — 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, a stochastic background from the early universe, and a host of more exotic or unanticipated processes.

<u>Principal Education Goals</u>: LIGO has been 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 undergraduates and outreach activities for the public. In 2004 NSF entered into a cooperative agreement with Caltech and Southern University/Baton Rouge to build the LIGO Science Education Center at the Livingston, LA site. Construction on the Center began in early FY 2006.

<u>Connections to Industry</u>: 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).

<u>Management and Oversight</u>: LIGO is sponsored by NSF and managed by Caltech under a cooperative agreement. Under the current agreement, NSF oversight is coordinated internally by a dedicated LIGO program director in the Division of Physics (MPS), who also participates in the Physics Division Project Advisory Team (PAT). NSF conducts annual scientific and technical reviews involving external reviewers and participates in meetings of the LIGO Scientific Collaboration (LSC) as well as making site visits to the Hanford, WA and Livingston, LA interferometers. During the AdvLIGO construction phase, NSF will continue the activities described above and exercise more intensive oversight through more frequent reporting requirements, step up interaction with the project personnel, and schedule reviews and site visits at least twice yearly and more frequently if the need arises. The NSF LIGO program director will work closely with the LIGO Deputy Director for the AdvLIGO Project, David Shoemaker of MIT. Project management techniques used in the successful completion of the initial LIGO construction will be employed to benefit management of the AdvLIGO construction.

<u>Current Status of Phase I</u>: 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. Five science runs have been performed or are in progress: S-1, in the period from August 23, 2002 to September 9, 2002, with a sensitivity of about a factor of 100 from the design goal; S-2 lasted 59 days from February 14, 2003 to April 14, 2003, with a sensitivity of about a factor of 10 from the design goal; S-3 in the period from October 31, 2003 to January 8, 2004, with a sensitivity of about a factor of 3.5 from the design goal; and S-4, with a sensitivity within a factor of 2 of the design goal, from February 22, 2005 to March 23, 2005. The addition of the Hydraulic External Pre-Isolation (HEPI) system to the Livingston interferometer to eliminate interference from anthropogenic noise sources was completely successful, as indicated in the improvement of the Livingston duty cycle from 21.8 percent in S-3 to 74.5 percent in S-4 leading to more than a 50 percent triple coincidence operation during the run. In addition, during S-4 all three interferometers showed high sensitivity, achieving levels within a factor of 2 of design sensitivity. The improvements achieved in the intervals between all science runs have been remarkable. S-5, operating at a somewhat better sensitivity than the design goal, began on

November 4, 2005, and has a planned duration of eighteen months. The coincident duty cycle — the percentage of time during which all three facilities are operating simultaneously — has generally risen over the history of the science runs, and it is projected to be at least 70% for S-5.

<u>Current Status of AdvLIGO</u>: The LIGO Laboratory submitted a proposal for AdvLIGO in early 2003. The proposal was reviewed in June 2003 and the project was considered to be ready for construction. The AdvLIGO project will upgrade the laser, suspension, seismic isolation, and optical subsystems. Advanced detector R&D has proceeded to the point where technology needed for the upgrade is well in hand. In particular the development of the laser subsystem has achieved performance levels essentially at the final specifications and part of the AdvLIGO seismic isolation system is already in operation at the Livingston site, where it has successfully eliminated excess vibration from various sources. The LIGO Laboratory will have spent $40.74 million of R&RA funds on advanced R&D for AdvLIGO in the period from FY 2000 – 2007.

Major milestones for Advanced LIGO include:

FY 2006-2007 Milestones:
- Finalize concept design and development of instrumentation

FY 2008 Milestones
- Place orders for long lead time items such as test mass optics;
- continue design of remaining instrumentation

FY 2009 Milestones:
- Acquisition of all components needed to begin installation in FY 2010
- Prepare for installation

FY 2010-11 Milestones:
- Installation begins at Livingston (FY 2010)
- Installation begins at Hanford (FY 2011)

FY 2012 Milestones:
- Commissioning begins at Livingston
- Commissioning begins at Hanford

FY 2013 Milestones:
- Livingston operational
- Hanford operational

<u>Funding Profile</u>:

Requested MREFC Funds for AdvLIGO
(Dollars in Millions)

FY 2008 Request	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	Total
$28.48	$42.81	$46.31	$36.25	$22.90	$7.60	$184.35

AdvLIGO Funding Profile

(Obligated Dollars and Estimates in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		**Grand Total**
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	
FY 2004 & Earlier	15.60						$15.60		$15.60
FY 2005	9.20						$9.20		$9.20
FY 2006 Current Plan	9.70						$9.70		$9.70
FY 2007 Request	6.24						$6.24	-	$6.24
FY 2008 Request				28.48	26.55		$26.55	$28.48	$55.03
FY 2009 Estimate				42.81	26.78		$26.78	$42.81	$69.59
FY 2010 Estimate				46.31	24.42		$24.42	$46.31	$70.73
FY 2011 Estimate				36.25	23.70		$23.70	$36.25	$59.95
FY 2012 Estimate				22.90	20.94		$20.94	$22.90	$43.84
FY 2013 Estimate				7.60	33.26		$33.26	$7.60	$40.86
FY 2014 Estimate					39.00		$39.00	-	$39.00
Subtotal, R&RA	$40.74		-		$194.65		$235.39		
Subtotal, MREFC		-		$184.35		-		$184.35	
Total, Each Stage		$40.74		$184.35		$194.65			$419.74

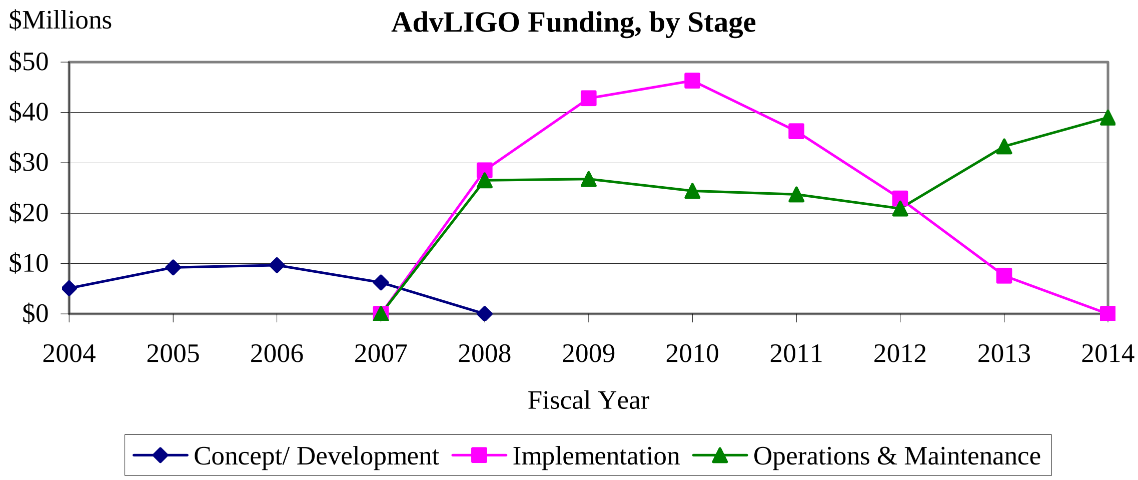
Note: Operations estimates for FY 2008 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

Detailed information pertaining to the data in the table is included below.

- Concept/Development: In the period of FY 2000 to FY 2007 the amount of $40.74 million will have been spent by the LIGO Laboratory for advanced R&D for concept development of AdvLIGO. The additional development work during the construction period will be directed to design development.

- Implementation: Funding during the Major Research Equipment and Facilities Construction (MREFC) phase of the project will provide for construction of the new instrumentation, including the laser, suspension, seismic isolation, and optical subsystems.

- Operations and Maintenance: R&RA funds will be used to maintain LIGO's existing experimental facilities and infrastructure during the construction, to continue the analysis of the data obtained during the operation of the original LIGO and LIGO's Education and Outreach activities, and to ramp up AdvLIGO's operations as construction reaches completion. Note that the operations and maintenance figures for AdvLIGO in FY 2008 through FY 2012 are the same as those shown for operations and maintenance of original LIGO in the Facilities section.



Future Science Support: Along with direct operations and maintenance support for LIGO, NSF supports science and engineering research directly related to LIGO activities by members of the LIGO Scientific Collaboration from universities through ongoing research and education programs. The annual support for such activities is estimated to be about $5 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 over 40 collaborating institutions with over 500 participating scientists. A Memorandum of Understanding (MOU) between the LIGO Laboratory and each institution determines the role and membership responsibilities of each participating 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 instrument improvements at the LIGO facilities. Caltech has nearly completed a successful search for a new LIGO director.

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 2,000 students per year have taken advantage of this opportunity. More formal programs at the sites include participation in the Research Experiences for Teachers (RET) Program, a set of "scientist-teacher-student" research projects in support of LIGO, and participation in the Summer Undergraduates Research Fellowships/Research Experiences for Undergraduates (SURF/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. Ground has recently been broken on the project to build the LIGO Science Education Center at the Livingston, LA site that will be filled with Exploratorium exhibits and will be the focal point for augmenting teacher education at Southern University and other student-teacher activities state-wide through the Louisiana Systematic Initiative Program. Outreach coordinators have been hired at each site to augment the existing activities. Continuing this year is Einstein@Home, a World Year of Physics project led by a collaborating scientist from the University of Wisconsin that allows almost anyone in the world with a computer to participate in LIGO data analysis.

ORGANIZATIONAL EXCELLENCE

The NSF Strategic Plan for FY 2003-2008 established Organizational Excellence (OE) as a fourth strategic goal for the agency, on a par with the agency's previously established goals of Ideas, Tools, and People. This reflects the fact that excellence in NSF's internal operations is essential to achieving the Foundation's mission and accomplishing its goals.

The activities that advance NSF's OE goal are funded through five appropriations accounts. Additional details on each account are provided in the respective chapters.

Salaries and Expenses (S&E) increases by $35.01 million, or 14.2 percent, to $281.82 million in FY 2007. These resources include funding for personnel compensation and benefits, information technology (IT) enabled business systems, administrative travel, training, rent, and other operating expenses necessary for effective management of NSF's research and education activities.

Office of Inspector General (OIG) increases by $500,000, or 4.4 percent, to $11.86 million in FY 2007. These resources include funding for personnel compensation and benefits, contract audits, training and operational travel, office supplies, materials, and equipment.

National Science Board (NSB) decreases by approximately $40,000, or -1.0 percent, to $3.91 million in FY 2007. These resources include funding for personnel compensation and benefits, contracts, training and operational travel, office supplies, materials, and equipment.

Program Accounts - Research and Related Activities (R&RA) and **Education and Human Resources** (EHR) - increase by $970,000, or 1.9 percent, to $51.94 million in FY 2007. OE costs directly related to programs are funded within R&RA and EHR. Direct program OE activities include funding for Intergovernmental Personnel Act (IPA) agreements and certain Foundation-wide activities such as major studies, evaluations, outreach efforts, and NSF contributions to interagency e-Government activities.

Organizational Excellence by Appropriations Account

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Salaries and Expenses	$223.45	$246.81	$281.82	$35.01	14.2%
Office of Inspector General[1]	10.17	11.36	11.86	0.50	4.4%
National Science Board	3.65	3.95	3.91	-0.04	-1.0%
R&RA Appropriation	35.08	40.97	41.94	0.97	2.4%
EHR Appropriation	7.72	10.00	10.00	-	-
Subtotal, Program Support	42.80	50.97	51.94	0.97	1.9%
Total	$280.07	$313.09	$349.53	$36.44	11.6%

Totals may not add due to rounding.

[1]The FY 2007 Request and the FY 2006 Current Plan for the OIG includes the NSF financial statement audit, which was funded through R&RA and EHR accounts in FY 2005 ($792,587). For more information, see the OIG appropriations chapter.

NSF Workforce
Full-Time Equivalents (FTE)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
S&E FTE Allocation					
Regular	*1,225*	*1,248*	*1,270*	*22*	*1.8%*
Student	*35*	*35*	*35*	*-*	*-*
Subtotal, S&E FTE Allocation	*1,260*	*1,283*	*1,305*	*22*	*1.7%*
S&E FTE Usage (Actual/Projected)					
NSF Regular	1,171	1,185	1,255	70	5.9%
NSF Student	29	35	35	-	-
Subtotal, S&E FTE[1]	1,200	1,220	1,290	70	5.7%
Office of the Inspector General[2]	63	61	63	2	3.3%
National Science Board[3]	12	13	14	1	7.7%
Arctic Research Commision	4	3	4	1	33.3%
Total, Federal Employees	1,279	1,297	1,371	74	5.7%
IPAs	134	170	170	-	-
Detailees to NSF	7	6	6	-	-
Contractors (est.)[4]	210	210	376	166	79.0%
Total, Workforce	1,630	1,683	1,923	240	14.3%

[1]Additional information regarding FTEs funded through the S&E appropriation are available in the S&E chapter.
[2]The Office of Inspector General is described in a separate chapter and is funded through a separate appropriation.
[3]The National Science Board is described in a separate chapter and is funded through a separate appropriation.
[4]As of July 2005, 386 contractors were engaged in NSF activities.

The staffing profile in the table above shows that a small but significant percentage of the NSF workforce – 170 people or more than 10 percent – consists of temporary employees hired through the authority provided by the IPA. IPAs do not count as federal FTE. A smaller number of visiting staff – roughly 40 people annually – are employed through NSF's own Visiting Scientist, Engineer, and Educator Program (VSEE). VSEEs count as federal FTE and are included in the *Federal Employees* total (see table above).

The use of IPAs and VSEEs, commonly referred to as rotators, has been a defining characteristic of NSF since its inception in 1950. As is noted in the most recent NSF Strategic Plan:

> "Over one half of NSF's Program Officers are non-permanent employees, either "on loan" from their host institutions as visiting scientists, engineers, and educators (VSEEs) or employed through grants to the home institutions under the terms of the Intergovernmental Personnel Act (IPA). These employees are a unique set of human resources, providing NSF with increased flexibility, new ideas and fresh science and engineering perspectives."

IPAs are considered federal employees for many purposes during their time at NSF, even though they remain employees of their home institutions. They are not paid directly by NSF and are not subject to federal pay benefits and limitations. NSF reimburses the home institution for the IPA's salary and benefits using the traditional grant mechanism. IPAs are also eligible to receive *per diem*, relocation expenses, and reimbursement for any income foregone because of their assignment at NSF (i.e., lost consulting fees). VSEEs, by contrast, receive a salary directly from NSF (through the S&E appropriation), although they continue to receive benefits through their home institutions, which are reimbursed by NSF.

While at NSF, rotators function in a manner virtually identical to the Foundation's permanent staff – leading the merit review process, overseeing awards, and shaping future program directions. To smooth their transition and help them appreciate their responsibilities at NSF, the NSF Academy leads a set of intensive training activities, including a three-day, off-site Program Management Seminar offered several times each year for new rotators and permanent staff.

R&RA and EHR Program Support funds account for roughly 15 percent of the total OE portfolio. More detailed information on the Program Support costs is shown in the tables below. The first table identifies the two cost elements of Program Support.

Summary of IPA and Program Support
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Percent
IPA Costs	24.08	30.60	31.00	0.40	1.3%
Program Related Administration	18.72	20.37	20.94	0.57	2.8%
Total, Program Support Costs	$42.80	$50.97	$51.94	$0.97	1.9%

Program Related Administration includes funding for certain Foundation-wide activities such as major studies, evaluations, outreach efforts, and NSF contributions to interagency e-Government activities. The following table breaks down the IPA costs by appropriation into basic compensation, travel, and other benefits.

IPA Costs by Appropriations
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Percent
R&RA					
IPA Compensation	$15.84	$20.05	$20.38	$0.33	1.6%
IPA Lost Consultant & Per Diem	1.54	2.14	2.13	-0.01	-0.5%
IPA Travel	2.05	2.91	2.92	0.01	0.3%
Subtotal, R&RA Costs	19.43	25.10	25.43	0.33	1.3%
EHR					
IPA Compensation	3.78	4.33	4.35	0.02	0.5%
IPA Lost Consultant & Per Diem	0.52	0.81	0.85	0.04	4.9%
IPA Travel	0.35	0.36	0.37	0.01	2.8%
Subtotal, EHR Costs	4.65	5.50	5.57	0.07	1.3%
Total, IPA Costs	$24.08	$30.60	$31.00	$0.40	1.3%

Totals may not add due to rounding.

Performance Highlights

With the addition of OE to the NSF Strategic Plan in FY 2003, NSF now conducts a comprehensive assessment of its OE activities as part of its GPRA reporting activities. Further information on the OE assessment is available in the Performance Information chapter of this document.

NSF has established the following four indicators to assess its progress toward the OE 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, and 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.

The OE assessment activities included input from the NSF Advisory Committee for GPRA Performance Assessment (AC/GPA) and the NSF Advisory Committee for Business and Operations (AC/B&O). NSF conducted a self-assessment for the second, third, and fourth indicators, which was then reviewed by the AC/B&O. The AC/GPA led the assessment of the merit review indicator.

The AC/GPA noted in its 2005 report that: "…NSF has demonstrated significant achievement for…the merit review indicator of the Organizational Excellence outcome goal." The report also notes: "the Advisory Committee on Business and Operations concluded that NSF demonstrated significant achievement for the other indicators of the Organizational Excellence goal."

SALARIES AND EXPENSES $281,822,000

The FY 2007 Budget Request for Salaries and Expenses (S&E) is $281.82 million, an increase of $35.01 million, or 14.2 percent, over the FY 2006 Current Plan of $246.81 million. Adequate funding for Salaries and Expenses, particularly for Staffing and Information Technology, is critical to the efficient operations of the agency.

Summary of Salaries and Expenses by Function
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Human Capital					
Personnel Compensation & Benefits	$145.56	$157.30	$171.48	$14.18	9.0%
Management of Human Capital	4.23	5.77	7.13	1.36	23.6%
Operating Expenses	9.98	9.68	10.06	0.38	3.9%
Travel	5.28	8.75	8.95	0.20	2.3%
Subtotal, Human Capital	165.05	181.50	197.62	16.12	8.9%
Technology and Tools					
Information Technology	28.69	33.06	51.62	18.56	56.1%
Space Rental	19.43	21.58	23.88	2.30	10.7%
Other Infrastructure	8.20	8.17	8.70	0.53	6.5%
Subtotal, Technology and Tools	56.32	62.81	84.20	21.39	34.1%
Business Analysis	2.08	2.50	-	-2.50	-100.0%
Total, Salaries and Expenses	$223.45	$246.81	$281.82	$35.01	14.2%

Totals may not add due to rounding.

S&E NSF Workforce
(Full-Time Equivalent (FTE) and Other Staff)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
NSF S&E -- Regular	1,225	1,248	1,270	22	1.8%
NSF S&E -- Student	35	35	35	-	-
Subtotal, FTE Allocation	1,260	1,283	1,305	22	1.7%
Detailees to NSF	7	6	6	-	-
Contracted Adm. Functions[1]	210	210	376	166	79.0%
Total, Workforce	1,477	1,499	1,687	188	12.5%

[1]This estimate is based on contractor head count information.

Appropriation Language

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; ~~$250,000,000~~*$281,822,000*: Provided, That contracts may be entered into under "Salaries and Expenses" in fiscal year ~~2006~~*2007* for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year. (*Science Appropriations Act, 2006.*)

Adjustments to Base

Salaries and Expenses
Budgetary Resources Summary
(Dollars in Millions)

	Enacted /Request	Rescission	Transfers[1]	Total Budgetary Resources	Lapsed	Obligations Incurred /Estimated
FY 2005 Actual	225.00	-1.80	0.25	223.45	-	223.45
FY 2006 Current Plan	250.00	-3.19	-	246.81	-	246.81
FY 2007 Request	281.82	-	-	281.82	-	281.82
$ Change from FY 2006	31.82			35.01		
% Change from FY 2006	12.7%			14.2%		

[1] Transferred to NSF from the Department of State for an award to the Civilian Research and Development Foundation.

Summary of Major Changes *(Dollars in Millions)*

S&E FY 2006 Current Plan…………………………………………….…………...……..$246.81

Human Capital +$16.12

Funding for Human Capital increases by $16.12 million to a total of $197.62 million, an 8.9 percent increase over the FY 2006 Current Plan. The major components of this increased investment are:

- $171.48 million for Personnel Compensation and Benefits, an increase of $14.18 million, which includes an increase of 70 full-time equivalents (FTE) by the end of FY 2007 as well as comparability and locality pay and costs related to employee benefits.
- $7.13 million for Management of Human Capital, which represents an increase of $1.36 million from the FY 2006 Current Plan. The additional funds will support the Foundation's strategic initiative to implement an enhanced, integrated human capital program that encompasses all aspects of human resources, and employee development efforts offered through the NSF Academy.
- $10.06 million in general operating expenses associated with NSF's programmatic responsibilities, an increase of $380,000; and
- $8.95 million for Travel, an increase of $200,000 over the FY 2006 Current Plan.

Technology and Tools +$21.39

Funding for Technology and Tools is $84.20 million, which represents an increase of $21.39 million, or 34.1 percent, over the FY 2006 Current Plan. The major components of this investment are:

- $51.62 million for Information Technology (IT), an increase of $18.56 million. Funds will be used for IT security, grants management and e-Government capabilities, a human capital system, enterprise architecture, and infrastructure maintenance and operations. This level will allow the Foundation to perform network modernization, implement security enhancements, and develop next generation grants management capabilities, including planning and implementation work for becoming a Grants Management Line of Business service provider to other agencies.
- $23.88 million for Space Rental, an increase of $2.30 million over the FY 2006 Current Plan. The increase is required to offset rapidly rising GSA rental costs, rising real estate taxes, increased utility costs, and acquiring additional space to accommodate the growth in staff.
- $8.70 million for Other Infrastructure needs, an increase of $530,000. The additional funds are required primarily to offset rising physical security costs.

NSF Business Analysis -$2.50

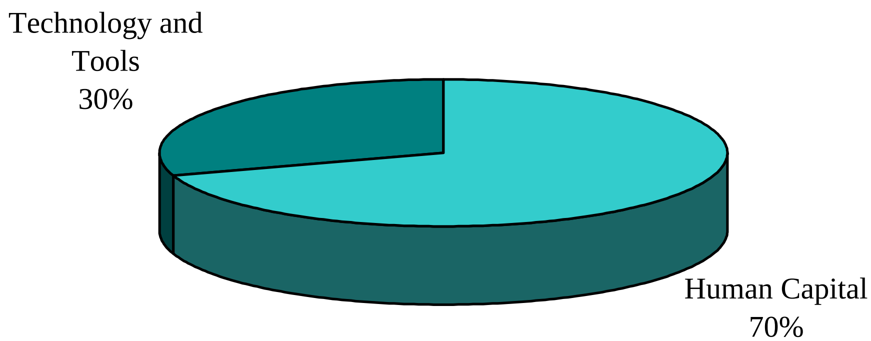
The multi-year Business Analysis will be completed in FY 2006. No funds are requested in FY 2007. $2.50 million was requested in FY 2006.

Subtotal, Changes +$35.01

FY 2007 Request, S&E……………………….………………………………………....$281.82

SALARIES AND EXPENSES – FY 2007 REQUEST BY MAJOR FUNCTION

FY 2007 S&E Request of $281.81 Million



With the rapidly changing character of research, new demands are placed on NSF staff and systems. Proposals today address more complex scientific questions, involve a wider array of collaborations, and increasingly, cross disciplinary boundaries.

NSF maintains its commitment to excellent, results-oriented management and stewardship. To solidify this endeavor, the NSF Strategic Plan was modified in FY 2003 to incorporate Organizational Excellence (OE) as a strategic goal, on a par with NSF's established science and engineering goals of Ideas, Tools, and People. Organizational Excellence reinforces the idea that excellence in management underpins all of the Foundation's activities and calls on us to be "an agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices." The focus of the Organizational Excellence goal on human capital and technologies and tools resonates strongly with the President's Management Agenda (PMA) goals in critical business disciplines and adds momentum to our ongoing efforts.

Many OE initiatives are derived directly from the multi-year NSF Business Analysis, which is important in supporting our integrative, multidisciplinary approach to management excellence and to achieving results. These efforts, directly or indirectly, help NSF provide first-rate customer service to proposers, reviewers, and grantees.

The increase requested in FY 2007 supports additional staffing to handle the growing workload, additional travel funds to ensure adequate management and oversight of our portfolio, and additional rented space for new staff. This increase will also provide for the development of next generation grants management capabilities, including planning and implementation work for becoming a Grants Management Line of Business service provider to other agencies.

HUMAN CAPITAL ($197.62 million)

The FY 2007 request for Human Capital totals $197.62 million, an increase of $16.12 million, or 8.9 percent, over the FY 2006 Current Plan of $181.50 million. These investments consist of four major components: Personnel Compensation and Benefits, Management of Human Capital, Operating Expenses, and Travel.

Human Capital Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Personnel Compensation and Benefits	$145.56	$157.30	$171.48	$14.18	9.0%
Management of Human Capital	4.23	5.77	7.13	1.36	23.6%
Operating Expenses	9.98	9.68	10.06	0.38	3.9%
Travel	5.28	8.75	8.95	0.20	2.3%
Total, Human Capital	$165.05	$181.50	$197.62	$16.12	8.9%

Totals may not add due to rounding

Personnel Compensation and Benefits ($171.48 million)

Personnel Compensation & Benefits

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount[3]	Change over FY 2006 Percent
Regular FTE Allocation	*1,225*	*1,248*	*1,270*		
Regular FTE Usage (actual/projected)	*1,171*	*1,185*	*1,255*	*70*	5.9%
Regular Salary					
Base Salary	$111.56	$114.17	$119.62	$5.45	4.8%
Salary Cost of Additional FTE	-	1.35	6.97	-	-
COLA & Locality Pay[1]	-	2.94	2.06	-	-
Subtotal, Regular FTE Salary	$111.56	$118.46	$128.65	$10.19	8.6%
Student FTEs	*29*	*35*	*35*	-	-
Student Salary	$0.89	$0.97	$1.00	$0.03	3.1%
Total, FTEs	*1,200*	*1,220*	*1,290*	*70*	*5.7%*
Subtotal, FTE Pay	$112.45	$119.43	$129.65	$10.22	8.6%
Benefits and Other Compensation[2]	$33.11	$37.87	$41.83	$3.96	10.5%
Total, PC&B	$145.56	$157.30	$171.48	$14.18	9.0%

[1]The pay increase includes the prior year's COLA and Locality Pay increase, nine months of the budget year's COLA and Locality Pay increase, within grades and adjustments to FTE payroll hours.

[2]This category includes employee benefits, detailees to NSF, terminal leave, awards, and other benefits.

[3]The increase in the FY 2007 base salary reflects the full annual cost of employees hired throughout FY 2006.

The FY 2007 request for Personnel Compensation and Benefits is $171.48 million, an increase of $14.18 million, which includes an increase of 70 full-time equivalent (FTE) employees to 1,255 FTE for FY 2007 as well as comparability and locality pay and costs related to employee benefits. The FY 2007 request includes an increase in allocation of 22 full-time equivalent (FTE) to 1,270 FTE in FY 2007. NSF will hire staff throughout FY 2007 and plans to reach the full allocation of 1,270 by end of the year. A comprehensive staffing review will be undertaken in February and March 2006 with the goal of developing an allocation for the additional FTE by April.

Management of Human Capital ($7.13 million)

The FY 2007 Management of Human Capital request is $7.13 million, an increase of $1.36 million, or 23.6 percent, from the FY 2006 Current Plan of $5.77 million. This increase will enable the Foundation to continue implementing an enhanced, integrated human capital system that encompasses all areas of human resources including recruitment, classification, skill gap analysis, workforce planning, performance management, and employee development. The enhanced activities will incorporate e-Government solutions, address the President's Management Agenda (PMA), support the Office of Personnel Management's Human Resource Line of Business, expand e-Learning, and augment the curricula, content, and knowledge management portfolio of NSF's Academy.

Summary of Management of Human Capital by Function
(Dollars in Millions)

Management of Human Capital	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Strategic Human Capital Management	2.66	4.20	5.00	0.80	19.0%
NSF Academy	1.57	1.57	2.13	0.56	35.7%
Total, Management of Human Capital	$4.23	$5.77	$7.13	$1.36	23.6%

- **Strategic Human Capital Management**
  Strategic Human Capital Management encompasses a broad range of activities related to the planning and management of NSF's workforce. In FY 2007, NSF will increase its spending on these activities, from $4.20 million to $5.0 million. In addition, $2.50 million is requested in the Technology and Tools section of the Salaries & Expenses (S&E) account for the IT infrastructure necessary to support these activities. This overall investment is needed to sustain NSF efforts to recruit and retain a highly qualified and highly motivated workforce. In FY 2006, NSF is establishing a comprehensive workforce-planning framework that will guide strategic and operational human capital efforts for the next 3-5 years; enabling NSF managers to more effectively target and recruit needed resources.

  In FY 2007, NSF will continue to upgrade and refine this framework by providing a comprehensive suite of interconnected capabilities, including robust analytics, skill gap assessment tools, interactive workforce planning and forecasting tools, ongoing development and refinement of NSF's competency based approach to human resource management, and implementation of more targeted and timely recruitment and compensation strategies.

  In addition, FY 2007 funding will be used to support and enhance the following critical human capital activities:
  - Streamlining of NSF human capital operational activities (human resource action processing, liaison with payroll services provider, etc.) to better support strategic human capital efforts;

- Upgrades to NSF's automated recruiting system to improve ease of use and decrease processing time; and
- Improvements to NSF's employee programs, including comprehensive health services and a robust employee assistance program.

- **NSF Academy**
  In FY 2007, NSF will increase spending from $1.57 million to $2.13 million to support supervisory, management, and leadership education and training programs; maintain a progressive leadership position in the use of learning technology; and further develop curricula, programs, and other learning opportunities. Collectively, these activities will facilitate staff development at all grade levels throughout the Foundation. Specific initiatives will include:

  - Establishing an NSF career counseling office and implementing a pilot mentor-protégé program for NSF administrative employees.
  - Offering a series of courses in support of NSF's business processes, expanding and enhancing knowledge management communities of practice, and providing transition meetings to reduce the learning curve for new managers.
  - Offering an After-Hours program to further the education of staff, developing a comprehensive education program for job families identified through the Business Analysis, and enhancing the orientation program for rotators, science assistants, and supervisors.
  - Developing and implementing Mobile Learning, a new concept that uses emerging technology to provide greater opportunities for distance learning.

  In addition to these funds, $490,000 is requested in the Technology and Tools section of the S&E account to support the multi-year effort to implement a Learning Management system.

Operating Expenses ($10.06 million)

Operating Expenses increase by $380,000, or 3.9 percent, to $10.06 million in FY 2007. These include direct costs of supplies, equipment, and other operating expenses necessary for the management of NSF's research and education activities.

Travel ($8.95 million)

Travel increases by $200,000, or 2.3 percent, to $8.95 million in FY 2007. These resources fund travel required for an enhanced oversight of existing awards as 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.

TECHNOLOGY AND TOOLS ($84.20 million)

The FY 2007 request for Technology and Tools is $84.20 million, an increase of $21.39 million, or 34.1 percent, from the FY 2006 Current Plan of $62.81 million. These investments consist of three major components: Information Technology, Space Rental, and Other Infrastructure.

Technology and Tools Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Information Technology	$28.69	$33.06	$51.62	$18.56	56.1%
Space Rental	19.43	21.58	23.88	2.30	10.7%
Other Infrastructure	8.20	8.17	8.70	0.53	6.5%
Total, Technology and Tools	$56.32	$62.81	$84.20	$21.39	34.1%

Information Technology

The FY 2007 Information Technology request is $51.62 million, an increase of $18.56 million from the FY 2006 Current Plan. This level will enable the Foundation to address key PMA initiatives and support a world-class infrastructure that is responsive to customer needs. Commencing in FY 2006, NSF will initiate plans to leverage its capability and experience base to provide grants management services as one of the Grants Management Line of Business consortium leads.

Summary of Information Technology by Function
(Dollars in Millions)

Information Technology	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
IT Security	$1.70	$2.00	$5.00	$3.00	150.0%
Next Generation Grants Mgmt & e-Gov Initiatives	2.20	3.20	8.20	5.00	156.3%
New Human Capital System	0.70	1.60	2.50	0.90	56.3%
Enterprise Architecture	0.60	0.60	1.10	0.50	83.3%
Applications Maintenance	10.40	10.90	12.55	1.65	15.1%
- *Finance and Administrative Applications*	4.80	4.80	4.30	-0.50	-10.4%
- *FastLane and Legacy Grants Applications*	5.60	6.10	8.25	2.15	35.2%
IT Infrastructure Maintenance and Operations	13.09	14.76	22.27	7.51	50.9%
Total, Information Technology	$28.69	$33.06	$51.62	$18.56	56.1%

- ***IT Security***
  In FY 2007, NSF will increase spending from $2.0 million to $5.0 million, a level consistent with the high priority the Foundation places on IT security. These investments allow NSF to acquire and deploy automated configuration management tools that manage patches and provide proactive protection and risk management strategies. While NSF’s security program is strong, continued investment in robust solutions is needed to meet evolving and more serious threats. Critical investments are needed in network security, application security, testing tools, automated vulnerability assessment, and remediation and intrusion detection services. NSF will fully fund certification and accreditation of activities including risk assessments, security and contingency

planning, and business continuity capability. Without this level of investment, NSF will not be able to deploy tools and practices to address emergent threats, or provide layered security capabilities needed to assure a sound security posture.

- ***Next Generation Grants Management and e-Government Initiatives***
  In FY 2007, funding for this initiative will increase from $3.20 million to $8.20 million. With increased funding, new capability in the grants management applications and e-Government initiatives will be initiated. While NSF has had great success with its external customer-facing system, notably FastLane, which receives and manages proposals, the rest of the end-to-end proposal processing systems have not received a comparable investment. Currently NSF relies on legacy applications that vary widely in their functional support capability, application age, sustainability, and integration with other applications to support crucial business functions. Specific areas for investment include migrating and integrating with e-Government initiatives (i.e., Grants.gov and E-Authentication), supporting internal grants administration (proposal, review, and award management), strategic information and knowledge management capabilities, and customer relationship systems. These applications will eliminate the need for manual processing, printing, and storage of proposal processing files for nearly all of the proposals received by NSF. Recognized as a leader in the federal E-Authentication initiative, NSF FastLane became one of the first agency applications to be E-Authentication-enabled in December 2005. In FY 2006 and FY 2007 NSF will continue to E-Authentication-enable other key applications.

  Additionally, NSF has been designated as one of three initial Consortia Provider Candidates (CPC) for the Grants Management Line of Business (GMLoB). This designation recognizes NSF's current capabilities and success as a model for other agencies. NSF will begin planning to leverage its extensive capability and experience base to provide grants-management-related services for other government agencies.

  NSF is preparing a business case to identify and analyze possible service offerings and the appropriate approach to serve as a consortia provider candidate. NSF will begin developing the infrastructure and capabilities necessary to cross-service other grants-making agencies in anticipation of providing support in FY 2007. An important outcome of this business case is to identify resources needed as a consortia provider candidate for the GMLoB. Funding resources will be realigned to accommodate NSF's provider role in GMLoB, currently estimated at approximately $13 million in FY 2007.

- ***New Human Capital Management Systems***
  In FY 2007, NSF will increase support from $1.60 million to $2.50 million. NSF will acquire tools to support the initiatives identified in the NSF Human Capital Management Plan, automate critical human resource functions in alignment with the Human Resource Line of Business, and continue implementation activities in support of the new Learning Management System planned for deployment in FY 2006.

  The automation of Human Capital functions and the Learning Management System will support NSF initiatives that embody a world-class, knowledge-rich workforce. Currently, NSF systems are independent and stove-piped in nature, lack effective communication capabilities with one another, and do not adequately support Human Resource activities. Capital investments in broad-scope electronic Human Capital capabilities will provide an integrated technology solution set to address all aspects of Human Capital related requirements. Investments in the new Human

Capital System include contractor-provided information technology services and hardware to support the applications and capabilities as they are deployed.

- ***Enterprise Architecture***
  In FY 2007, NSF will increase support from $600,000 to $1.10 million. This investment includes services that support Chief Information Officer requirements. The enterprise architecture efforts will define current, target, and transitional architecture to frame future NSF IT investments, such as the next generation grants management and human capital initiatives, and IT infrastructure maintenance investments. This investment will be used for continued support of OMB mandated requirements for an earned value management system to improve the management of major IT projects and will support more integrated investment planning.

- ***Applications Maintenance***
  In FY 2007, NSF will increase support for this activity from $10.90 million to $12.55 million. Increased funding will support finance and administrative applications, FastLane, and legacy grants applications. At this level, NSF will sustain ongoing maintenance and planned enhancements for these critical grants management applications.

- ***IT Infrastructure Maintenance and Operations***
  In FY 2007, support for IT Infrastructure Maintenance and Operations will be increased from $14.76 million to $22.27 million. This funding will restore basic maintenance and operations levels for ongoing operations and support new efforts essential for system modernization such as directory services and tools to manage configuration, quality assurance, and software testing. The funding will also provide additional infrastructure to support new initiatives including the Grants Management Line of Business and Grants.gov activities. Increased funding will also allow for planned technical refresh, additional system redundancy and stability, database migration, and initiatives to expand and automate support to accommodate an increasingly distributed 24x7 user community. Funding will also support help desk services that are currently under-funded and require expansion to support new applications, and support improvements to desktop configuration management.

Summary of Space Rental and Other Infrastructure by Function

(Dollars in Millions)

Space Rental & Other Infrastructure	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Space Rental	$19.43	$21.58	$23.88	$2.30	10.7%
Other Infrastructure	8.20	8.17	8.70	0.53	6.5%
- Administrative Contracts	*4.04*	*3.43*	*3.81*	*0.38*	11.1%
- Government Goods and Services	*2.25*	*2.52*	*2.52*	-	-
- Administrative Services Equipment & Supplies	*1.91*	*2.22*	*2.37*	*0.15*	6.8%
Total, Space Rental & Other Infrastructure	$27.63	$29.75	$32.58	$2.83	9.5%

Space Rental

The FY 2007 request for Space Rental is $23.88 million, an increase of $2.30 million, or 10.7 percent, over the FY 2006 Current Plan. These resources are needed to offset escalating GSA rental costs, rising real estate taxes, increased utility costs, and accommodating the space needs of an expanded staff.

Other Infrastructure

In FY 2007, support of Other Infrastructure will increase from $8.17 million to $8.70 million.

Other Infrastructure funding supports three major sets of activities:

> *Administrative Contracts* support will increase from $3.43 million to $3.81 million due primarily to rising physical security costs. Administrative contracts are used to provide facility management and administrative support services.
>
> *Government Goods and Services* support will remain unchanged at $2.52 million. This funding covers security guards, building improvements such as electrical upgrades, and building renovations.
>
> *Administrative Services Equipment & Supplies* will increase from $2.22 million to $2.37 million. New, more efficient processes require a new cadre of distributed multi-function equipment. High-speed scanners will be purchased for decentralized e-Records support. Funds will also be used to purchase furniture for newly acquired space and for routine building renovations.

Salaries and Expenses by Object Class

The following table shows the planned distribution of general operating expenses (GOE) by object class and salaries and benefits. A brief explanation of each general operating expenses category follows.

General Operating Expenses by Object Class
and Salaries and Benefits
(Dollars in Thousands)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Travel and Transportation of Persons	$5,281	$8,770	$8,970	$200	2.3%
Transportation of Things	193	200	200	-	-
Rental Payments to GSA	19,432	21,580	23,888	2,308	10.7%
Communications, Utilities and Misc. Charges	1,663	1,500	1,500	-	-
Printing and Reproduction	255	175	175	-	-
Advisory and Assistance Services	9,480	11,081	12,471	1,390	12.5%
Other Services	8,406	9,305	10,205	900	9.7%
Purchases of Goods & Srvcs from Gov't. Accts	2,304	2,515	2,515	-	-
Medical Care	753	550	575	25	4.5%
Operations and Maintenance of Equipment	22,707	25,804	37,525	11,721	45.4%
Supplies and Materials	2,968	2,550	2,600	50	2.0%
Equipment	4,448	5,477	9,718	4,241	77.4%
Subtotal, GOE	77,891	89,507	110,342	20,835	23.3%
Salaries and Benefits (PC&B)	145,559	157,300	171,480	14,180	9.0%
Total, S&E	$223,450	$246,807	$281,822	$35,015	14.2%

Totals may not add due to rounding

Description of categories:

- **Travel and Transportation of Persons** increases by $200,000 from the FY 2006 Current Plan. These resources fund travel required for planning, outreach, and increased oversight of existing awards as recommended by the agency's Inspector General.

- **Transportation of Things** consists of household moves associated with bringing new staff to NSF. Resources for this activity remain unchanged from the FY 2006 Current Plan.

- **Rental Payments to GSA** includes the rent charged by GSA for NSF's facility in Arlington, Virginia, and four floors in an adjacent building. The increase of $2.31 million in FY 2007 is required to fund GSA's estimate for currently occupied space, real estate taxes, an increase in Federal Protective Service guard costs, and a modest increase in leased space.

- **Communications, Utilities, and Miscellaneous Charges** includes all costs for telephone lines and services, both local and long distance, and postage. Resources for this activity remain unchanged from the FY 2006 Current Plan.

- **Printing and Reproduction** includes contract costs of composition and printing of NSF's publications, announcements, and forms, as well as printing of stationery and specialty items. These costs remain unchanged from the FY 2006 Current Plan.

- **Advisory and Assistance Services** includes development, learning, and career enhancement opportunities offered through the NSF Academy, contracts for human capital operational activities, work life initiatives, outreach, and related services. Included in the FY 2007 request is an increase of $1.39 million to enhance human capital and curriculum development initiatives.

- **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. The FY 2007 request for other services increases by $900,000 over the FY 2006 Current Plan, primarily for facility management, physical security, and administrative support services.

- **Purchases of Goods and Services from Government Accounts** includes reimbursable services purchased from GSA. These costs include security guard services, some electrical upgrades, and modest renovation services. The FY 2007 request remains unchanged from the FY 2006 Current Plan.

- **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. To offset inflation, these costs increase by $25,000 in FY 2007.

- **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). Costs increase by $11.72 million in FY 2007 to enhance IT security, address PMA initiatives, support a world-class infrastructure and prepare to serve as a Center of Excellence in Grants Management for other government agencies.

- **Supplies and Materials** include office supplies, library supplies, paper and supplies for the NSF central computer facility, and miscellaneous supplies. Costs increase by $50,000 in FY 2007 to enhance library resource materials.

- **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. These costs increase by $4.24 million in FY 2007. Acquisition of equipment is needed to support new initiatives including the Grants Management Line of Business and Grants.gov activities, as well as to replace and modernize existing equipment.

NATIONAL SCIENCE BOARD $3,910,000

The National Science Foundation Appropriations Act of 2002 provided for a separate appropriation line item for the National Science Board (NSB, the Board) beginning in FY 2003. Accordingly, this FY 2007 NSB 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 $3.91 million, a decrease of $40,000 over the FY 2006 Current Plan. The FY 2007 Budget Request will continue to enable the NSB to fulfill its policy-making and oversight responsibilities for the NSF and provide independent advice to the President and the Congress on significant national policy issues in science and engineering (S&E) research and education.

National Science Board Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Percent
Personnel Compensation and Benefits	$1.46	$1.62	$1.70	$0.08	4.9%
Other Operating Expenses	2.19	2.33	2.21	-0.12	-5.2%
Total	$3.65	$3.95	$3.91	-$0.04	-1.0%
Full-Time Equivalent Employees	12	13	14	1	7.7%

Totals may not add due to rounding.

Appropriation Language

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 (42 U.S.C. 1863) and Public Law 86-209 (42 U.S.C. 1880 et seq.), ~~$4,000,000~~*$3,910,000*: Provided, That not more than $9,000 shall be available for official reception and representation expenses. *(Science Appropriations Act, 2006.)*

National Science Board
Budgetary Resources Summary
(Dollars in Millions)

Fiscal Year	Enacted/ Request	Rescission	Total Budgetary Resources	Lapsed	Obligations Incurred/Estimated
FY 2005 Actual	4.00	-0.03	3.97	-0.32	3.65
FY 2006 Current Plan	4.00	-0.05	3.95	-	3.95
FY 2007 Request	3.91	-	3.91	-	3.91
$ Change from FY 2006	-$0.09		-$0.04		-$0.04
% Change from FY 2006	-2.3%		-1.0%		-1.0%

Totals may not add due to rounding.

Adjustments to Base

Within the Office of the National Science Board FY 2005 appropriation a total unobligated balance of $320,000 lapsed, due to unexpected delays in NSB-sponsored activities and in hiring of NSB staff.

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 NSB was established by the Congress both to serve as an independent national science policy body, and to oversee and guide the activities of the NSF. It has dual responsibilities to: a) provide national science policy advice to the President and the Congress; and b) establish policies for the NSF. 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 S&E 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 six times a year to review and approve major NSF awards and new programs, oversee and provide policy direction to NSF, and deal with significant science and engineering related national policy issues. It 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. 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. It also 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 (OMB).

National Science Board Activities

Because it is required to establish the Foundation’s policies within the framework of applicable national policies as set forth by the President and the Congress, the NSB 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 Research and Development Investment Criteria of the PMA. The Board has received reports from the chairs 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 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 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, science and engineering education, the science and technology workforce, 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 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. The standing Committee on Audit and Oversight 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 members of the Committee on Programs and Plans (CPP) review proposals for major 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.

The Board established a Committee on Strategy and Budget (CSB) in 2001 to focus on strategic planning and budget initiatives for NSF. Review of the Foundation's Budget Request is also vested in CSB. The Committee on Education and Human Resources (EHR) focuses on Foundation activities in such priority areas as S&E workforce development, math and science education, and underrepresented populations and regions in S&E programs. The EHR Subcommittee on S&E Indicators manages the process for development and review of the Board's biennial statistical report, *S&E Indicators*.

During the last year, the Board accomplished a great deal in terms of its mission to provide oversight and policy direction to the Foundation, including: reviewed and endorsed the OIG Semi-annual Reports to Congress and approved NSF management responses; approved the NSF FY 2006 Budget Request for transmittal to OMB; approved the Foundation's annual Merit Review Report; provided review and decisions on eight major awards or proposal funding requests; approved a new process for the development, review, approval and prioritization of large facility projects by NSF, and reprioritized NSB-approved but not-yet-funded Major Research Equipment and Facilities Construction (MREFC) account projects. At the request of Congress, the Board has undertaken to develop and establish a new vision for the National Science Foundation in the 21st Century. The Board delivered the *2020 Vision for the National Science Foundation* (NSB-05-142) to Congress in mid January 2006. It also completed the assessment of the NSF Merit Review System and the *Report of the National Science Board on the National Science Foundation's Merit Review System* was delivered to Congress in early October 2005; and oversaw the full implementation of its report on *Setting Priorities for Large Research Facilities Projects Supported by NSF*.

In terms of advice to the President and the Congress, the Board published the *Broadening Participation in Science and Engineering Faculty* (NSB-04-41) report, and *Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation* (NSB-05-77); approved *Long-Lived Digital Data Collections: Enabling Research and Education in the 21st Century* (NSB-05-40) report, provided testimony to Congressional Hearings; interacted with the White House Office of Science and Technology Policy in meetings and forums on S&E issues; and responded to specific questions and inquiries from Senators and Representatives. Board meetings and deliberations have also become much more open in accord with the Government in the Sunshine Act, as directed by the NSF Act of 2002. The NSB continued to improve its outreach and communications with the Congress, other agencies, various interest groups and the outside S&E research and education community. During the FY 2006, the Board will have initiated examinations of major issues related to Engineering Education, possible improvements to, and impact of, the biennial *Science & Engineering Indicator*s report, and a study of the role of the federal government in supporting international partnerships in science. At the request of Congress, and in accord with Board discussions at its 2005 Retreat, the Board will also be establishing a Commission on 21st Century Education in Science, Mathematics and Technology to formulate a national strategy for developing and implementing a bold new approach for addressing the problems and opportunities of U.S. K-12 education in sciences, mathematics, engineering and technology, including its interconnections with undergraduate education in these fields and in K-12 education.

National Science Board FY 2007 Budget Request

The Board's Budget Request for FY 2007 seeks resources to carry out its statutory authority and to strengthen the Board's oversight responsibilities for the Foundation. Enhanced Board responsibilities established in the NSF Authorization Act of 2002 and directed by Congressional Report language include: an expanding role in prioritizing and approving MREFC 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 the projected impact on the science and technology (S&T) workforce, research infrastructure, size and duration of grants, and under-represented populations and regions.

Effective communications and interactions with our constituencies contribute to the Board's work of identifying priority S&T policy issues, and developing policy advice and recommendations to the President and Congress. To this end, the Board will continue to increase communication and outreach with the university, industry and the broader S&E research and education community, Congress, Federal S&T agencies, and the public. The Board's activities will aim to support U.S. global leadership in discovery and innovation based on a continually expanding and evolving S&T enterprise in this country, and will ensure a principal role for NSF programs in providing a critical foundation for S&E research and education.

Among other activities in FY 2007, the Board expects to complete its study of NSF identification, development, review and funding of transformative research, and provide new guidance for NSF policies regarding such research. It will also provide national policy recommendations following completion of the work of its Commission on 21st Century Education in Science, Mathematics and Technology. While many of these recommendations will be at a national system level, a number will also focus specifically on the role NSF can and should play in supporting the development of an adequate and diverse S&E workforce for the future. The Board's examination of university level engineering education will also be completed and recommendations provided in FY 2007. The NSB International Task Force expects to complete its examination of the role of the U.S. Government in international science and engineering in response to the changes that have occurred in recent years to the global dynamics for science and engineering (S&E) research, education, politics, and workforce. The Board will continue to review and approve NSF's actions for creating major NSF programs and funding large projects. It is also expected that the Board will be reviewing a new NSF Strategic Plan that is expected to be developed to address the Board's 2020 Vision for NSF.

Essential to the conduct of Board business is a small and independent, yet adequate, core of full-time senior policy, clerical and operations staff, supplemented by short-term temporary contractual support as needed for various NSB endeavors. This core of NSB support is augmented by the Foundation as it continues to provide accounting, logistical and other necessary resources in support of the NSB and its missions. In addition to the NSBO's essential and independent resources and capabilities, external advisory and assistance services are especially critical to support production of NSB reports and supplement the NSB staff's general research and administration services to the Board. These external services provide the Board and its Office with the flexibility to respond independently, accurately and quickly to requests from Congress and the President, and to address issues raised by the Board itself.

By statute, the Board is authorized five professional positions and other clerical staff as necessary. In consultation with the Congress, the Board has defined these five professional positions as NSB senior S&E policy staff, and the clerical positions as NSB staff that support Board operations and related activities associated with the conduct of its meetings and oversight responsibilities. In August 2003, the NSB Chair charged the new NSB Executive Officer, who reports directly to the NSB Chair and also serves as the Director of the NSB Office (NSBO), with identifying options for broadening the NSBO staff capabilities to better support the broad mission of the NSB. The NSBO staff provides both the independent resources and capabilities for coordinating and implementing S&E policy analyses and development, and the operational support that are essential for the Board to fulfill its mission.

The full impact of increasing the number of professional positions to the statutory level, along with necessary clerical and support staff, is expected to occur in FY 2007, with increased attention to addressing new skill requirements. Nevertheless, the results of a strategic restructuring of Board Office management and operations over the last two years (since implementation of the changes incumbent in the December 2002 NSF Re-Authorization Act), has led to more efficient use of appropriated resources while retaining the ability to support an active Board agenda. More efficient operations, in combination with a completion of Board Office equipment upgrades in FY 2006, has positioned the Board to propose an FY 2007 budget that represents a reduction of $40,000, or -1.0 percent, over the FY 2006 Current Plan.

Personnel Compensation and Benefits and General Operating Expenses

(Dollars in Thousands)

National Science Board Funding

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Personnel Compensation and Benefits	$1,460	$1,620	$1,700	$80	4.9%
Other Operating Expenses	992	971	801	-170	-17.5%
Advisory and Assistance Services	1,490	1,350	1,400	50	3.7%
Representation Costs	8	9	9	-	-
Total	$3,950	$3,950	$3,910	-$40	-1.0%

Totals may not add due to rounding.

OFFICE OF INSPECTOR GENERAL $11,860,000

The Appropriations Act that funds the National Science Foundation provides for a separate appropriation heading for NSF's Office of Inspector General (OIG). Accordingly, the FY 2007 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 2007 Budget Request for OIG is $11.86 million, which represents an increase of $500,000 over the FY 2006 Current Plan of $11.36 million.

Office of Inspector General Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Personnel Compensation and Benefits	$7.78	$7.90	$8.20	$0.30	3.8%
Other Operating Expenses[1]	2.39	3.46	3.66	0.20	5.8%
Total	$10.17	$11.36	$11.86	$0.50	4.4%
Full-Time Equivalent Employment	63	61	63	2	3.3%

Totals may not add due to rounding.

[1]The cost of the annual audit of NSF's financial statements is included in this request.

Appropriation Language

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, as amended, ~~$11,500,000~~*$11,860,000,* to remain available until September 30, ~~2007~~*2008. (Science Appropriations Act, 2006.)*

Office of Inspector General
Budgetary Resources Summary
(Dollars in Millions)

Fiscal Year	Enacted/ Request	Rescission	Carryover/ Recoveries	Total Budgetary Resources	Obligations Incurred/Estimated
FY 2005 Actual	10.11	-0.08	1.22	11.25	10.17
FY 2006 Current Plan	11.50	-0.14	1.09	12.45	12.45
FY 2007 Request	11.86	-	-	11.86	11.86
$ Change from FY 2006	$0.36			-$0.59	
% Change from FY 2006	3.1%			-4.7%	

Totals may not add due to rounding.

Explanation of Carryover

Within the Office of Inspector General appropriation, a total of $1.09 million was carried forward into FY 2006 to fund priority audits that are contracted out, contracts for financial analysis and other technical support for OIG investigations, contract support for information technology and other administrative needs of the office, and personnel compensation costs. It may also be used to protect the appropriation against unanticipated variations between obligations and expenditures.

OIG Responsibilities

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, reviews, and investigations. To provide the diverse skills, training, and experience necessary to oversee NSF's varied programs, the 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 performs audits of grants, contracts, and cooperative agreements funded by the Foundation's programs. The Office also conducts audits and reviews of both internal agency programs and external organizations that receive NSF funding to ensure that financial, administrative, and programmatic activities are conducted economically, effectively, and in compliance with agency and federal requirements. OIG is also responsible for overseeing 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. The Office contracts with a public accounting firm to conduct the financial statements audit, and in the past the cost was allocated proportionately to the accounts audited. Beginning in FY 2006, funds to cover the complete cost of the financial audit are requested in this appropriation. OIG also audits financial, budgetary, and data processing systems used by NSF to develop the financial statements. In addition, the Office performs multi-disciplinary reviews – involving auditors, attorneys, management analysts, investigators, and others as needed – of financial, management, and program operations to 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 all the allegations it receives 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, civil litigation, or resolution via settlement agreements and institutional compliance plans. OIG refers other cases to the Foundation for administrative resolution and, when appropriate, recommends modifications to agency policies and procedures to ensure the integrity in NSF's systems. 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 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Personnel Compensation and Benefits	$7,780	$7,900	$8,200	$300	3.8%
Travel and Transportation of Persons	219	260	270	10	3.8%
Advisory and Assistance Services	1,904	2,880	3,060	180	6.3%
Communications, Supplies & Equipment, and Other Services	262	320	330	10	3.1%
Total	$10,165	$11,360	$11,860	$500	4.4%

Totals may not add due to rounding.

The OIG request for FY 2007 includes funding for the annual audit of NSF's financial statements, which NSF program accounts had funded prior to FY 2006. The cost of this audit, which is conducted by an independent contract auditor under OIG oversight, is reflected in the table as part of Advisory and Assistance Services.

Most of the 4.4 percent increase for FY 2007 would be applied to higher personnel cost-of-living costs, the two additional FTEs, and the increased costs of audits conducted by CPA firms under contract to OIG. With the additional staffing resources, our primary audit focus would be to increase attention in four areas that pose the greatest challenge to the agency: (1) award oversight and monitoring, including the management of large infrastructure projects and implementation of a risk-based program for monitoring NSF's 30,000 active awards; (2) strategic management of NSF resources, including NSF's implementation of its multiyear Business Analysis contract recommendations, agency planning for future workforce needs, and the strengthening of its administrative capabilities; (3) NSF processes to oversee the scientific performance of its research and to assess the results of its long-term investments in major research programs; and (4) specific program issues, such as managing the U.S. Antarctic Program and ensuring the transparency of NSF's merit review process.

OIG would enhance its ability to target risky awardees by improving its automated trend analysis techniques for scanning prior OIG and A-133 audit findings and by achieving a more comprehensive understanding of the nature and size of NSF's funded programs. For example, past studies have shown high risks in awards involving cost sharing and awards made to large school districts under NSF's urban systemic initiative program. This level of funding would also allow for a thorough review of labor-effort costs charged to NSF awards. Labor effort is the single largest cost in NSF awards, and it is frequently cited in audit reports for weak internal controls. OIG would also continue to focus attention on audits of international institutions, which are becoming an increasing part of NSF's research portfolio but often are not subject to the terms and conditions of NSF's other awardees. Our efforts would be coordinated with other OIGs and international audit organizations to evaluate the need for developing standardized financial, accounting, and audit requirements for accountability of funds provided by all sources.

Staff is also needed to expand the OIG's Quality Control Reviews of non-Federal CPA firms conducting audits for grantees under the Single Audit Act (OMB Circular A-133). Because NSF relies extensively on these audits for post-award monitoring and financial statement reporting, 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. More resources would allow the Office to continue to improve its Quality Control Review program.

Criminal, civil and administrative investigative cases continue to become more complex, resulting in increased interactions with NSF, awardee administrators, and the Department of Justice to develop effective resolutions to complex institutional fraud cases through settlements and compliance programs. In the wake of Sarbanes/Oxley and the increased attention it places on corporate financial fraud, we have seen an increase in allegations of institutional fraud. We anticipate an increasing need to use forensic financial services to resolve these cases. This year alone these services enabled us to resolve two cases resulting in $1.6 million in recoveries and the implementation of institutional compliance programs. These cases require significantly more staff time, specialized knowledge, and strong analytical skills, and they offer the potential for greater recoveries and systemic changes in institutions to ensure detection of fraud and the proper use of Federal funds. OIG's proactive investigative reviews have been productive in detecting potential misuse of NSF funds, the complexity of allegations of wrongdoing received by OIG has steadily increased, and additional resources are needed to ensure diligent investigations of the growing number of substantive complaints. Further, NSF is increasingly funding organizations other than traditional academic institutions. Investigations into these organizations require additional resources to fully understand the scope and complexity of the matter.

In recent years, OIG has made a concerted effort to educate NSF staff and the research communities about avoiding the kinds of problems that lead to investigations, unfavorable audit findings, or administrative corrective actions. The request level will enable us to commit a modest amount of staff time to OIG outreach programs that help NSF staff, awardee institutions, and researchers better understand system and grant management issues and the preventive or corrective measures that may need to be taken. Auditors, investigators, and other staff regularly participate in outreach activities, and as NSF programs increase in complexity and number, OIG has seen a commensurate increase in requests for information from universities and research institutions. The NSF OIG will continue to play a leadership role in convening international conferences and workshops that are well attended by NSF's counterparts in other countries, including their auditing and investigative components, to discuss common concerns.

MAJOR MULTI-USER RESEARCH FACILITIES $1,109,740,000

The FY 2007 request for Facilities totals $1,109.74 million, a $110.43 million increase, or 11.1 percent, over the FY 2006 Current Plan of $999.31 million. All operations and maintenance of multi-user facilities and research resources are funded through the Research and Related Activities (R&RA) account; most 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 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 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.

NSF Funding for Major Multi-User Research Facilities
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Facilities	475.13	514.32	580.30	65.98	12.8%
Polar Facilities and Logistics	277.91	301.82	339.64	37.82	12.5%
Federally Funded R&D Centers	178.07	183.17	189.80	6.63	3.6%
Total, Major Multi-user Research Facilities	$931.11	$999.31	$1,109.74	$110.43	11.1%

To describe the life-cycle of a facility, the Foundation has adopted a set of distinct stages in its Facilities Management and Oversight Guide[1]. 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, upgrade, 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. The Facilities Management and Oversight Guide requires the use of Project Advisory Teams (PATs) to advise program officers on business, financial, legal, and other related aspects of projects and project management. The PAT is composed of the Deputy Director for Large Facility Projects (DDLFP) who provides advice and assistance during the implementation phase of the facility life cycle and staff from the Directorates, the Office of the General Counsel, the Office of Legislative and Public Affairs, and the Office of Budget,

[1] The current version of the Facility Management and Oversight Guide can be found at www.nsf.gov/pubs/2003/nsf03049/nsf03049.pdf. The Facilities Management and Oversight Guide is currently being revised as part of an ongoing process to improve NSF's facility management and oversight; the revised "Facility Manual" is expected to be released during FY 2006. New guidelines for the development, review, and approval of major research facilities were released in September, 2005 and are available on the web: www.nsf.gov/bfa/docs/mrefcguidelines1206.pdf.

Finance and Award Management. The DDLFP also provides advice and assistance to directorates, divisions and program staff throughout the life cycle of a facility project.

Major Multi-User Research Facility Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Facilities	$475.13	$514.32	$580.30	$65.98	12.8%
Academic Research Fleet	83.20	84.60	97.70	13.10	15.5%
Advanced Modular Incoherent Scatter Radar	10.50	8.00	-	-8.00	-100.0%
Cornell Electron Storage Ring	16.62	14.56	14.71	0.15	1.0%
Gemini Observatory	15.48	18.26	20.00	1.74	9.5%
Incorporated Research Institutes for Seismology	11.90	12.00	12.90	0.90	7.5%
Integrated Ocean Drilling Program	36.70	29.00	4.50	-24.50	-84.5%
Large Hadron Collider	10.51	13.36	18.00	4.64	34.7%
Laser Interferometer Gravitational Wave Observatory	32.00	31.68	33.00	1.32	4.2%
MREFC Facilities[1]	165.60	209.83	284.97	75.14	35.8%
National High Magnetic Field Laboratory	25.50	25.74	26.50	0.76	3.0%
National Nanofabrication Infrastructure Network	13.90	13.76	13.89	0.13	0.9%
National Superconducting Cyclotron Laboratory	17.50	17.32	17.60	0.28	1.6%
Network for Earthquake Engineering Simulation	17.94	20.31	21.27	0.96	4.7%
Other Facilities[2]	17.78	15.90	15.26	-0.64	-4.0%
Polar Facilities and Logistics[3]	$277.91	$301.82	$339.64	$37.82	**12.5%**
Antarctic Facilities and Logistics	155.73	199.96	218.09	18.13	9.1%
Polar Logistics	105.32	101.86	112.42	10.56	10.4%
South Pole Station[1]	16.86	-	9.13	9.13	N/A
Federally Funded R&D Centers[4]	$178.07	$183.17	$189.80	$6.63	**3.6%**
National Astronomy and Ionospheric Center	12.42	12.16	12.16	-	-
National Center for Atmospheric Research	80.68	83.36	86.85	3.49	4.2%
National Optical Astronomy Observatory	37.94	36.91	40.05	3.14	8.5%
National Radio Astronomy Observatory	47.03	50.74	50.74	-	-
Total	$931.11	$999.31	$1,109.74	$110.43	11.1%

[1]Funding levels for MREFC projects in this table include initial support for operations and maintenance provided through the R&RA account as well as implementation support provided through the MREFC account.

[2]Other Facilities includes support for the continued phase out of program and contract activities for the Ocean Drilling Program, predecessor to the IODP, and other physics and materials research facilities.

[3]Polar Facilities and Logistics excludes Polar Environment, Safety and Health, which is classified as a "tool" but not as a facility.

[4]Federally Funded R&D Centers does not include the Science and Technology Policy Institute, which is an FFRDC but not a research platform.

In September 2005, NSF released "A Joint National Science Board-National Science Foundation Management report on *Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation*." This "Setting Priorities" report outlines in general terms the changes NSF will implement to its large facilities process over the next year, and was developed largely in response to the February 2004 National Academies' report by the same name. That report recommended an open process for selecting new projects to be funded, establishing well-defined criteria and including maximum community input. The results of this final prioritization should be "discussed, explained and documented". NSF concurs with these recommendations and continues to refine the MREFC process to ensure that decisions are clearly documented and explained, and selection criteria clearly articulated.

Performance information related to NSF-funded facilities is available in the Performance Information chapter of this document and in the FY 2005 NSF Performance and Accountability Report (NSF-06-01). A list of Major Research and Equipment Facilities Construction (MREFC) projects can be found in this chapter. For a full discussion of these projects, please refer to the MREFC chapter.

FACILITIES

Academic Research Fleet

Project Description: The Academic Research Fleet consists of 26 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. Included is 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 about the structure and dynamics of the oceans. Through use of these facilities scientists contribute to advances made in areas such as climate variability, marine ecosystems, fisheries, and ocean-related natural hazards such as tsunamis.

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 via satellite 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 72 percent of the operating funds for the Fleet, while the remaining operating costs are divided proportionally among the other vessel using agencies. NSF also coordinates with ship-operating and ship user academic institutions through its connection with and support of 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 (OCE) and in NOAA and ONR 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 scale 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 institutions, a chief of marine technicians, schedulers and finance administrators may also be involved in facility management.

Current Project Status: 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 other ocean agencies and the ocean science community, the Federal Oceanographic Facilities Committee (FOFC) is currently revising the 2001 report on long-range plans for renewal of the federal and academic oceanographic research and survey fleet, which will be published this year. The FY 2007 request for operation of the Academic Research Fleet totals $77.50 million, up $4.50 million from the FY 2006 Current Plan. In addition, several activities are requested or underway to support the upgrade of the U.S. Academic Research Fleet.

FY 2007 will see continued development and construction of a new deep submergence capability to replace the pioneering submersible human occupied vehicle (HOV) ALVIN. This project, begun in FY 2004, will take six years in total and cost approximately $22.83 million. The FY 2007 support for this effort is $5.10 million. Also underway is the conversion of a seismic research vessel acquired with NSF funds in FY 2004 (renamed the R/V Langseth), with state-of-the-art 3-D seafloor surveying equipment, to replace the aging R/V Maurice Ewing. A third project currently underway is the design and potential construction of a series of up to three Regional Class Research Vessels (RCRVs), utilizing the experience in ship building and contracting of the Naval Sea Systems Command (NAVSEA). These ships will be built sequentially over a period of six years starting in FY 2007 with the first year of construction, FY 2007, planned for $15.10 million. A design competition is currently underway. These investments will open significant expanses of the deepest ocean to exploration, enhance coastal research activities 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**
	HOV	Langseth	RCRV	Other		
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	3.00	6.24	0.30	0.46	72.50	$82.50
FY 2005	2.23	8.00	2.00		70.97	$83.20
FY 2006 Current Plan	5.50	2.50	3.60		73.00	$84.60
FY 2007 Request	5.10		15.10		77.50	$97.70
FY 2008 Estimate	3.00		12.00		79.80	$94.80
FY 2009 Estimate	3.00		13.09		82.20	$98.29
FY 2010 Estimate			14.11		84.66	$98.77
FY 2011 Estimate			14.13		87.19	$101.32
FY 2012 Estimate			14.20		90.00	$104.20

NOTE: Operations estimates for FY 2008 and beyond have been developed based on current cost profiles and are not intended to reflect actual budget requirements. 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 scientific need. In past 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. More recently, planning has included 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, FOFC prepared a report titled "Charting the Future for the National Academic Research Fleet", which defined a federal interagency renewal strategy for the national academic research fleet. The report is currently being revised by FOFC; however, significant changes for renewal of the academic fleet are not anticipated. Major upgrade expenditures indicated in implementation requests for FY 2007 and out-years are for continuation of development of a new deep submergence vehicle and replacement of Regional Class ships. The reconfiguration of a recently acquired seismic research vessel will be completed in FY 2006. All implementation activities for the Academic Research Fleet have been funded through the R&RA account.

- 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 through a cooperative agreement 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, 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 subjected to NSF's standard merit review process. The fleet supports approximately 2,600 users per year, which is based on the total number of individual researchers, postdoctoral associates, graduate and undergraduate students, teachers, K-12 students and observers who have participated in cruises.

Science Support: Through the existing interagency MOU, which enables the efficient operation of the academic fleet, NSF pays only for ship time used by NSF-funded awards.

Advanced Modular Incoherent Scatter Radar (AMISR)

Project Description: The Advanced Modular Incoherent Scatter Radar 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 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 us understand the processes influencing global change, and observations during solar storms will help us 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 NSF's Science and Technology Centers. 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.

Principal Education Goals: 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.

Partnerships and Connections to Industry: Manufacturing of the 12,000 antenna element units (AEUs) is being done by Sanmina SCI, a global electronics manufacturing firm with headquarters in San Jose, CA. The solid-state power amplifier for the first 4,000 units was manufactured by Comtech PST, a company based in Melville, New York. The remaining amplifiers will be manufactured by Sanmina. The construction of the AMISR support structure and the foundation work in Alaska was performed by VECO Corp., an Alaska-based company that specializes in management, engineering design and construction for the oil and power industries. The support structure at Resolute Bay will be built by a Canadian company, ATCO Frontec using the VECO design.

Management and Oversight: Overall project management and oversight is the responsibility of the program manager for Upper Atmospheric Facilities within the Division of Atmospheric Sciences (in GEO). A Project Advisory Team has been appointed, which includes the Deputy Director for Large

Facility Projects and members from the Directorate for Geosciences, the Office of Polar Programs, the Office of Budget Finance and Award Management, and the Office of the General Council. As required in the cooperative agreement for the AMISR construction, SRI has assembled a Technical Advisory Committee to provide technical oversight in the design and development of the AMISR system. SRI has also written a Project Execution Plan that describes the AMISR work breakdown structure, management structure, project milestones, and final test and acceptance plan.

Current Project Status: The cooperative agreement for AMISR construction was approved on August 1, 2003. A prototype system using 8 AMISR panels has been deployed at the Jicamarca Radio Observatory in Peru, and based on satisfactory test results, an additional 16 panels were produced and shipped to Gakona, Alaska, in early in 2005 for further on-site testing. Both prototype systems are now being used for scientific studies.

The first 32 panels of the AMISR system at Poker Flat, Alaska, were installed in November 2005 and used for interference testing in partnership with Air Force personnel from Clear Air Force Station. No interference was observed and SRI received official certification to continue testing the 32 panels at Poker Flat. The remaining 96 panels will be assembled at SRI and shipped to Alaska in Spring 2006, completing the first AMISR face. Construction of the AMISR support structure at Resolute Bay is underway, and completed panels for the two AMISR faces being deployed at Resolute Bay are scheduled to be shipped to Resolute Bay in August 2006.

Future milestones for the project are outlined below:

FY 2006 Milestones:

- Poker Flat Activities
  - Complete and install remaining 96 panels
  - Poker Flat (1 face) constructed
  - Poker Flat system test complete and operational
- Resolute Bay Activities:
  - 256 panels integrated and tested at SRI
  - 256 panels along with foundation materials, support scaffolding and distribution shelters shipped to Resolute Bay via sealift
  - Installation of 256 panels at Resolute Bay begins

FY 2007 Milestones:

- Poker Flat Activities
  - Operations phase
- Resolute Bay Activities:
  - Installation of 256 panels on two faces completed
  - 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 funding of \$12.40 million was provided in FY 2004, as indicated in the table below. Funds allocated in previous fiscal years for prototype development are also shown in the table.

AMISR Funding Profile
(Dollars in Millions)

	Concept/ Development	Implementation	Operations & Maintenance	Total, NSF
FY 2001 & Earlier	3.60			$3.60
FY 2002	3.40			$3.40
FY 2003		14.00		$14.00
FY 2004		12.00	0.40	$12.40
FY 2005		10.00	0.50	$10.50
FY 2006 Current Plan		8.00	2.70	$10.70
FY 2007 Request			3.00	$3.00
FY 2008 Estimate			3.00	$3.00
FY 2009 Estimate			3.07	$3.07
FY 2010 Estimate			3.15	$3.15
FY 2011 Estimate			3.22	$3.22
FY 2012 Estimate			3.30	$3.30

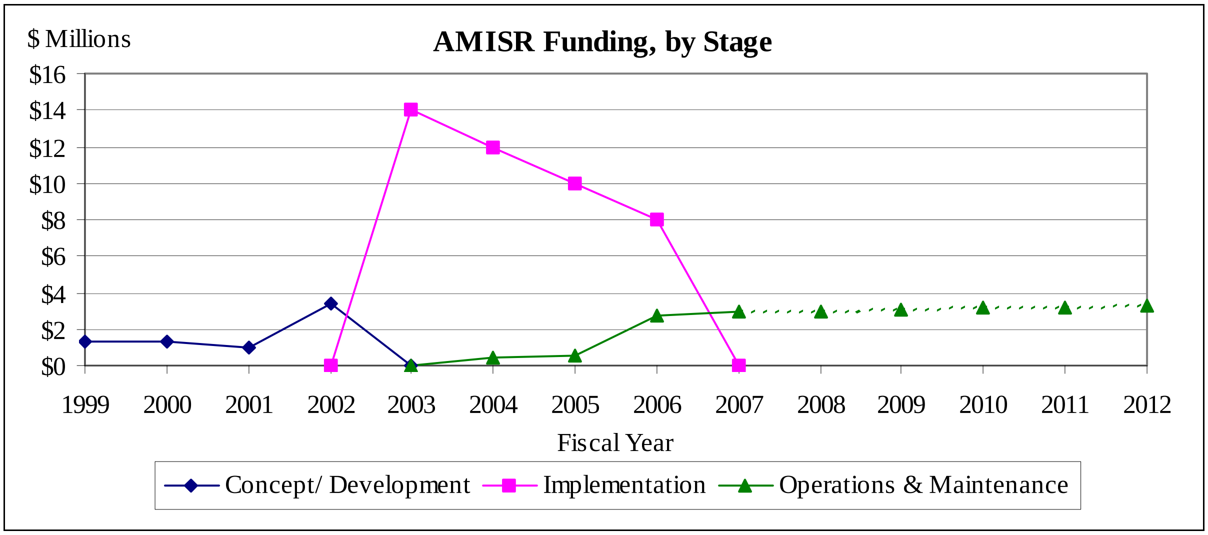
NOTE: A steady state of about $3 million in operations support is expected to occur in or about FY 2008. The expected operational lifespan of this project is 40 years, beginning in FY 2007. Operations estimates for FY 2008 and beyond have been developed based on current cost profiles and are not intended to reflect actual budget requirements. 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 FY 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: The AMISR face at Resolute Bay will be operational by spring 2006. The two remaining faces will be deployed at Resolute Bay in 2007.

- Operations and Maintenance: SRI has submitted 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 MIT, and the University of Western Ontario. 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 level of support for this research is estimated to be about $5 million.

Cornell Electron Storage Ring (CESR)

Project Description: The Cornell Electron Storage Ring (CESR) is a facility that supports research in elementary particle physics as well as research 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 has modified CESR and the associated particle detector (CLEO) for operation over the energy range 1.5 GeV to 5.6 GeV per beam in order to address high-priority physics questions that relate to the c-quark and possible gluon states that cannot be addressed elsewhere. The transformed collider and detector are named CESR-c and CLEO-c respectively.

The CESR facility is also used by the materials research community at the Cornell High Energy Synchrotron Source (CHESS). CHESS is a high-intensity, high-energy X-ray source supported by NSF. It 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, materials research and environmental sciences.

Principal Scientific Goals: CESR-c and CLEO-c explore a large set of critical weak and strong interaction phenomena, knowledge of which is either lacking or fragmentary. These in turn drive theoretical advances that both extend and enable the full program of physics targeted by many new-generation detectors, such as those at the Stanford Linear Accelerator Center (SLAC), Fermilab, and the Large Hadron Collider (LHC), and 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 the 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 with help from an Assistant Director and an Associate Director for Accelerator Physics. The CLEO-c experiment is the sole CESR-c experiment in particle physics, and this collaboration consists of users from about 20 U.S. institutions. The 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 is provided through the Division of Physics (PHY) of the Directorate for Mathematical and Physical Sciences (MPS) and by periodic site visits by NSF staff. 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 by NSF staff midway through the third year, of a five-year award initiated in FY 2003, with possible assistance from an external panel of experts.

CHESS is supported through the Division of Materials Research (DMR) of MPS, the Directorate for Biological Sciences (BIO), and by the National Institutes of Health (NIH). Those organizations provide management oversight for CHESS through regular site visits. DMR will provide $3.90 million to CHESS in FY 2007; BIO will provide $800,000.

Current Project Status: CESR reaches its final stages through the five-year cooperative agreement initiated in April 2003. Cornell University has modified 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. The FY 2007 Request for CESR totals $14.71 million. It is expected that the CESR-c and CLEO-c projects will cease by FY 2009.

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[1]

(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 2001		19.49	$19.49
FY 2002		19.49	$19.49
FY 2003		19.49	$19.49
FY 2004		18.00	$18.00
FY 2005 Actual		16.62	$16.62
FY 2006 Current Plan		14.56	$14.56
FY 2007 Request		14.71	$14.71
FY 2008 Estimate		15.00	$15.00
FY 2009 Estimate		10.00	$10.00
FY 2010 Estimate		-	-

NOTE: Operations estimates for FY 2008 and beyond have been developed based on current cost profiles and are not intended to reflect actual budget requirements. They will be updated as new information becomes available.

[1]Includes funding for CESR only. No funding for CHESS is included in this table.

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

- Management and Operations: The facility expects to operate about 8,000 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:

- Approximately 120 elementary and middle school students and 300 high school students were involved in activities hosted by the Laboratory for Elementary-Particle Physics. Over 450 people toured the Wilson Laboratory facility during this time frame;
- Approximately 65 undergraduate students participated in laboratory research or worked as technicians or in technical capacities such as computer operations;
- The Laboratory hosted 19 Research Experiences for Undergraduates (REU) and two Research Experiences for Teachers (RET) participants in collaboration with Wayne State University and George Mason University during the summer of 2005; 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 130 researchers from 25 U.S. and foreign institutions.

The CHESS facility serves a wide spectrum of experimental groups from universities, national laboratories and industry and is used by the materials research community, with typically 600-700 users per year.

Gemini Observatory

Gemini North dome/enclosure with setting sun (to left) lighting up bottom half of telescope through thermal vents (fully open). The observing slit is partially open revealing the truss and top end of the telescope. Credit: *Gemini Observatory/AURA*

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 4,200 meters. The telescope in Chile is located on Cerro Pachon, an outstanding photometric site, at an altitude of 2,700 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 previous instruments provides 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 play a central role in the education and training of U.S. astronomy and engineering students. An estimated 20 percent of the projected 400 users per year are 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. In FY 2004, the Director of the Gemini Observatory was awarded Chile’s Gabriela Mistral medal for the Observatory’s great contributions to cultural exchange and knowledge of the Universe by the Ministry of Education. This was the first time the medal has been awarded to a non-Chilean.

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, 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 in MPS, assisted during construction by an internal Project Advisory Team (PAT) with representation from the Office of the General Counsel, the Office of Legislative and Public Affairs, the Office of Budget, Finance and Award Management, and the Office of International Science and Engineering. During construction, a committee of outside experts regularly reviewed progress and reported to the partnership. With the start of scientific operations, the Gemini Board established an independent Visiting Committee that advises 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 2006. Under the terms of the international agreement, the partnership, after a management review, determined that it would not compete the management of the Observatory at this time. A proposal from AURA for operations during the period 2006 to 2010 was reviewed and an award to AURA for the next five years of operations has been approved by the National Science Board.

Current Project Status: Construction of both telescopes is complete and science operations are routine at both sites. Commissioning of facility instruments continues at both telescopes. The Chilean partner in Gemini, CONICYT, had a perennial problem paying operations contributions, though they 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 establish a fund whose proceeds would be used to develop astronomy for Chile. 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. The International Gemini Agreement has been amended to formalize the change.

Funding Profile: The FY 2007 Request totals $20.0 million, an increase of $1.74 million over the FY 2006 Current Plan of $18.26 million. Included in this total is enhanced operational and visitor support, as well as the continuation of funding of a new generation of advanced instrumentation and $1.0 million as the remaining contribution to the return of the U.S. share of Chilean capital.

Gemini Funding Profile
(Obligated Dollars and Estimates in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		Grand Total
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	
FY 1999 & Earlier	12.00		47.00	45.00	22.91		81.91	45.00	$126.91
FY 2000					8.38		8.38	-	$8.38
FY 2001					8.66		8.66	-	$8.66
FY 2002					12.50		12.50	-	$12.50
FY 2003					13.48		13.48	-	$13.48
FY 2004					13.27		13.27	-	$13.27
FY 2005 Actual					15.48		15.48	-	$15.48
FY 2006 Current Plan					18.26		18.26	-	$18.26
FY 2007 Request					20.00		20.00	-	$20.00
FY 2008 Estimate					24.69		24.69	-	$24.69
FY 2009 Estimate					25.07		25.07	-	$25.07
FY 2010 Estimate					25.46		25.46	-	$25.46
FY 2011 Estimate					26.50		26.50	-	$26.50
FY 2012 Estimate					27.16		27.16	-	$27.16
Subtotal, R&RA	$12.00		$47.00		$261.82		$320.82		
Subtotal, MREFC		-		$45.00		-		$45.00	
Total, Each Stage		$12.00		$92.00		$261.82			$365.82

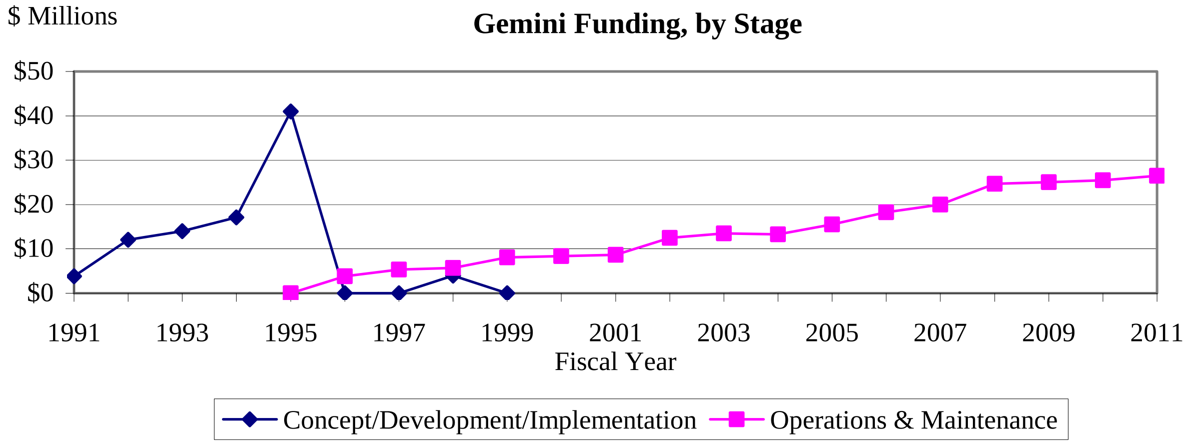
NOTE: Reporting of costs in the categories of implementation and operations and maintenance is as considered and reported by NSF in its response to OIG report 01-2001. FY 2005 - 2007 funding includes the cost of the Chilean capital return, consistent with the U.S. assumption of a portion of the Chilean share. FY 2005 funding includes one time costs of $0.55 million for improved internet connectivity and instrumentation. Funding under the current cooperative agreement ends in FY 2005. The figures for FY 2006-2011 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. The anticipated lifetime of the Observatory is 25 years. A steady state of about $25 million annually (plus inflation) is anticipated for the U.S. share of operations.

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 1980s." 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 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 include 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 percent of management, operations and maintenance. In FY 2005-2007, costs reflect Chilean capital return, consistent with U.S. assumption of a portion of Chilean share.



Renewal or Termination: The cooperative agreement for the support of Gemini operations expires in FY 2006. Under the terms of the international agreement, the partnership determined that it did not wish to compete the management of the Observatory at this time. A proposal from AURA covering operations from 2006-2010 was reviewed and an award for the next five years of operations has been approved by the National Science Board.

Associated Research and Educational Activities: The public information and outreach office at Gemini carries out local outreach to schools, teachers, and the general public. The office also coordinates and serves as a liaison for the outreach efforts of partner countries and provides 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.

Incorporated Research Institutes for Seismology (IRIS)

Project Description: IRIS is a consortium of 102 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 also leading the construction of the USArray component of the EarthScope MREFC project. IRIS is organized in four major program elements: (1) The Global Seismographic Network (GSN), which currently consists of a global deployment of 138 permanently installed digital seismic stations, most of which have real-time data access; (2) The Program for Array Seismic Studies of the Continental Lithosphere (PASSCAL), which manages a pool of portable seismometers that are made available to the seismology research community for scheduled regional and local scale studies; (3) The IRIS Data Management System (DMS), which 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.

Real-time data from the IRIS GSN forged the critical core of the early warning of the December 26, 2004 Sumatran Earthquake by the Pacific Tsunami Warning Center (PTWC). Within 8 minutes of the initial rupture of the magnitude 9 earthquake, GSN data flashed electronically via satellite and the Internet to the GSN Data Collection Center and then to the PTWC and the USGS National Earthquake Information Center.

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.

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 from around 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 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).

<u>Connections to Industry</u>: 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.

<u>Management and Oversight</u>: 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. However, all IRIS program and budget decisions are made by a nine-member Board of Directors. 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 Board of Directors 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 (in 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.

<u>Current Project Status</u>: 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 Academies. 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 twenty-two years, with support from the Foundation and federal partners, the IRIS consortium has grown to 102 full-member (voting) U.S. universities that operate core research facilities consisting of a GSN, PASSCAL, and a DMS. During the last cooperative agreement period, IRIS initiated a new Education and Outreach (E&O) program. The FY 2007 Request for IRIS totals $12.90 million, an increase of $900,000 over the FY 2006 Current Plan.

<u>Funding Profile</u>: 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 2001	1.90	11.38	$13.28
FY 2002	1.50	11.40	$12.90
FY 2003	3.70	9.50	$13.20
FY 2004	3.10	9.90	$13.00
FY 2005	2.85	9.05	$11.90
FY 2006 Current Plan	3.00	9.00	$12.00
FY 2007 Request	3.10	9.80	$12.90
FY 2008 Estimate	3.20	10.00	$13.20
FY 2009 Estimate	3.30	10.50	$13.80
FY 2010 Estimate	3.30	11.00	$14.30
FY 2011 Estimate	3.17	11.50	$14.67
FY 2012 Estimate	3.28	12.00	$15.28

NOTE: Operations estimates for FY 2008 and beyond have been developed based on current cost profiles and are not intended to reflect actual budget requirements. 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; the Global Seismographic Network (GSN); and the Data Management System in Seattle, WA.

- 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."

<u>Renewal or Termination</u>: Two reviews were stipulated in the last 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. Both reviews have now been completed. The latter review provided more information for the basis of the decision to allow the submission of a renewal proposal rather than to recompete the operation of this facility. A renewal proposal was submitted in September 2005 from the IRIS Consortium for continued management of the IRIS facilities and is under review.

<u>Associated Research and Education Activities</u>:

IRIS sponsors an active education and outreach program, which touches a vast number of individuals annually. There are over 2000 individuals on the IRIS mailing list, and over 100 K-12 schools and science centers are using seismographs provided by IRIS. The website visitors data in the table below indicate a yearly sum of unique visitors each month and shows the large increase in public interest after the Sumatra earthquake and tsunami. The large increase in posters distributed in FY 2005 is due to a new poster featuring seismic data from GSN recordings of the Sumatra earthquake, and from IRIS contributing a poster to American Geological Institute's Earth Science Week packet. IRIS partnered with the National Earth Science Teachers Association (NESTA) in FY 2005 to produce a seismology/IRIS focused issue of their journal *The Earth Scientist*. The journal has a regular distribution of 1,100 members and over 2,000 total copies were distributed in FY 2005. Seventeen public IRIS/SSA distinguished lectures were given to audiences of up to 400 in FY 2005. IRIS holds a variety of professional development workshops each year for K-12 teachers and/or college faculty, varying in length from 1 hour to 4 days; in FY 2005, 6 such workshops were held. The K-12 students number assumes each teacher interacts with 80 students per year and continues to teach new students each year. In addition IRIS sponsored a 2-day workshop for 16 undergraduate and graduate students to provide training in the use of the Seismic Processing Workshop (SPW) software. The museum display visitors number is the total number of visitors to the museums that have an IRIS/USGS display.

Year	K12 Students taught by IRIS trained teachers	Undergrad summer interns	Graduate students sponsored to attend annual IRIS workshop	K-12 Teachers trained in IRIS workshops	College faculty trained in 1-day workshops	Museum display visitors	Posters distributed	Website visitors
FY 1998	3,400	2	28	43		500,000	2,000	
FY 1999	5,300	6	22	23	35	2,000,000	5,000	
FY 2000	6,900	2	30	20	20	9,000,000	4,000	
FY 2001	12,000	3	33	65	25	9,000,000	3,000	250,000
FY 2002	18,000	6	24	76	16	9,000,000	2,000	300,000
FY 2003	27,000	9	25	117	25	9,000,000	4,000	450,000
FY 2004	35,000	4	20	103	18	16,000,000	8,500	650,000
FY 2005	43,000	9	20	110	0	15,500,000	20,000	1,400,000

Science Support: The EAR/Geophysics and Continental Dynamics Programs and the OCE/Marine Geology and Geophysics Program provide most of the funds for NSF-sponsored research, totaling approximately $15 million per year. Funds permit deployment of PASSCAL instruments and use of GSN data stored at the DMS to solve major earth science problems.

Integrated Ocean Drilling Program (IODP)

Project Description: The Ocean Drilling Program (ODP) terminated in September 2003 with its final drilling programs in the North Atlantic. During the 18-year duration of the ODP, NSF provided 60% 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), begun 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 *IODP 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 at least $500 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, is undergoing testing in 2006 and 2007, and will be available for IODP operations in Fall 2007. NSF's contribution includes rebuilding the ODP drillship *JOIDES Resolution* to serve as the light Scientific Ocean Drilling Vessel (SODV) drillship, using $115 million in FY2005-07 MREFC funds. An initial period of *JOIDES Resolution* operations extended from June 2004 to January 2006; MREFC SODV shipyard conversion will begin in Fall 2006. Delivery of the rebuilt *JOIDES Resolution* to IODP is expected in August 2007, and it is likely that the ship will be renamed to reflect its greatly enhanced capabilities. The European Consortium for Ocean Research Drilling (ECORD), composed of 17 countries (including Canada), is participating in IODP and providing short-term use of chartered drilling platforms for Arctic and near-shore objectives. The People's Republic of China is an additional IODP participant, and Australia and several potential additional Asian members may join in the future.

IODP drilling operations 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 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 are made available to qualified scientists throughout the world for research projects.

Principal Scientific Goals: The IODP scientific program is identified in the *IODP Initial Science Plan: Earth, Oceans and Life*, and includes emphasis on the following research themes:

- The Deep Biosphere and the Sub-seafloor Ocean: 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.

- The Processes and Effects of Environmental Change: 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.

- Solid Earth Cycles and Geodynamics: 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 study the seismogenic zone responsible for large destructive earthquakes along active plate boundaries.

Principal Education Goals: 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.

Partnerships: MEXT and NSF are equal partners in the IODP and contribute equally to program operation costs. A consortium of 16 European countries and Canada (ECORD), and the People's Republic of China, have officially joined IODP. In addition to its financial contribution, the European consortium supplies additional drilling facilities for IODP for short-term operations in shallow water and the Arctic. Several other Asian countries and Australia may join in the near future.

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

Management and Oversight: NSF and MEXT have signed a Memorandum of Cooperation, which identifies procedures for joint management of a contract to an IODP Central Management Office (CMO). The CMO coordinates and supports 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 been contracted by NSF for the CMO activity. Drillship providers are responsible for platform operational management and costs. NSF provides the light drillship through contract with the U.S. System Integration Contractor (SIC), the 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 Agency for Marine-Earth Science and Technology (JAMSTEC), while the British Geological Survey manages European drilling contributions.

Scientific advice and guidance for IODP is provided through the scientific advisory structure (SAS). The SAS 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. Membership in the SAS is proportional to IODP financial contribution.

The Division of Ocean Sciences (in 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 serves as the contracting officer's technical representative on the CMO and SIC contracts, and another oversees the MREFC SODV activity.

Current Program Status and Future Program Planning: IODP started in FY 2004. A first phase of light drillship drilling activity started in mid-FY 2004 and continued into early FY 2006. The NSF-supplied light SODV drillship, converted using MREFC funds for IODP needs, will begin drilling in late FY 2007. The heavy drillship *Chikyu* is expected to begin scientific drilling operations in late FY 2007. European-funded drilling expeditions have occurred in two places: the northern Arctic, where several icebreakers, one modified for drilling, were used in late FY 2004 and early FY 2005; and in shallow coral reefs around Tahiti in late FY 2005 and early 2006. Future European-funded drilling is expected off of New Jersey on the U.S. east coast margin.

NSF and MEXT will contribute equally to IODP operations costs, with up to one-third of total costs contributed by the European consortium. NSF is requesting $25.80 million in FY 2007 for operation of the IODP program through the R&RA account (IODP SODV Operations & Maintenance and IODP Central Support).

Funding Profile: All funding for the operation of the ODP has been provided through the R&RA account. Implementation funding in FY 2005-2007 is MREFC account funding that supports the acquisition and outfitting of a drillship for use in the program. For more information on this project, please see the Scientific Ocean Drilling Vessel section of the MREFC chapter of this document.

Ocean Drilling Funding Profile

(Obligated Dollars and Estimates in Millions)

	ODP Operations & Maintenance	SODV Operations & Maintenance	IODP Operational Support	Total, NSF
FY 1997	27.09			$27.09
FY 1998	26.95			$26.95
FY 1999	28.13			$28.13
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	32.00		3.30	$35.30
FY 2004	-		35.75	$35.75
FY 2005	3.49		36.70	$40.19
FY 2006 Current Plan	2.80		29.00	$31.80
FY 2007 Request	2.00	21.30	4.50	$27.80
FY 2008 Estimate		57.00	4.64	$61.64
FY 2009 Estimate		58.60	4.77	$63.37
FY 2010 Estimate		60.70	4.92	$65.62
FY 2011 Estimate		62.00	5.06	$67.06
FY 2012 Estimate		64.00	5.40	$69.40

NOTE: Operations estimates for FY 2008 and beyond have been developed based on current cost profiles and are not intended to reflect actual budget requirements. They will be updated as new information becomes available.

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

- 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. Support for participation and drilling-related research performed by U.S. scientists is provided by NSF.

Renewal or Termination: IODP international agreements and contracts cover activities through FY 2013. Activities regarding IODP renewal are expected to commence in FY 2011.

Associated Research and Education Activities: 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. Three educational CD-ROMs with teaching activities, interviews with scientists, and operational footage 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.
- An 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 several 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 drillship JOIDES Resolution has visited U.S. ports approximately 10 times since 1994. At each visit, ship tours are given, and promotional and educational activities have been held at five of these port calls.
- JOI/ODP sponsors scientific research and planning workshops that commonly involve graduate students- many graduate students have sailed on the JOIDES Resolution.
- Finally, a highly successful "School of Rock" educator workshop was recently held aboard the JOIDES Resolution during a 16 day transit; participation by middle and high school teachers, museum educators and exhibit designers, and other educational professionals led to broadly-viewed daily webcasts as well as development of new curricular and museum outreach materials.

A breakdown by year and by category is reflected in the table below.

ODP/IODP Participation

Year	K-12	Undergrad	Graduate	Teachers
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
FY 2004	6,500	8,500	9,500	7,500
FY 2005	6,500	8,500	9,500	7,500
FY 2006 Estimate	130,000	8,500	9,500	21,000

Science Support: Over 2000 scientists from forty nations have participated on ODP and IODP cruises since 1985. About 900 of these have been U.S. scientists from over 150 universities, government agencies, and industrial research laboratories, with over 300 of them participating in more than one ODP cruise. Samples and data have been distributed to an additional 800 or more U.S. scientists. These 1,700+ direct U.S. users of ODP materials approach 15 percent of the U.S. geoscience community as identified by the American Geological Institute.

NSF provides most of the support for the participation of U.S. scientists in the IODP. The majority of the funding comes from the Division of Ocean Sciences, 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 expected to reach approximately $30 million annually.

Large Hadron Collider (LHC)

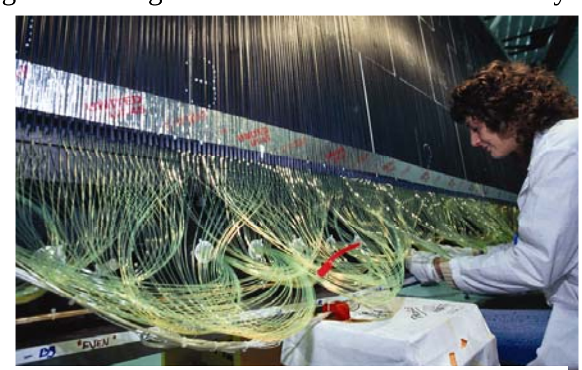
Project Description: The LHC will be the premier facility in the world for research in elementary particle physics. The facility will consist of a superconducting particle accelerator providing two, counter-rotating beams of protons, each beam having an energy up to 7 TeV (1TeV=10^{12} electron volts). The U.S. is involved in the construction of two particle detectors, A Toroidal LHC Apparatus (ATLAS) and the Compact Muon Solenoid (CMS). They are being constructed to characterize the different reaction products produced in the very high-energy proton-proton collisions that 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 awarded Major Research Equipment and Facilities Construction (MREFC) 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 the Department of Energy (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 per year. The remaining time is to be used for maintenance and testing.

U.S. LHC maintenance and operations, software and computing activities, funded through the R&RA account, is now ramping up with awards to UCLA (for CMS) and to Columbia University (for ATLAS). This includes some R&D for future detector upgrades.

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 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.



NSF's contribution to the international LHC project includes the construction of two detectors, the ATLAS and the CMS. The ATLAS tile calorimeter will collect the energy released in the LHC´s proton-proton collisions. Special plastic manufacturing techniques have been adapted to mass produce the ATLAS elements.

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 Division (in MPS) is responsible for day-to-day project oversight. The NSF program director also participates in an internal Project Advisory Team, including staff from the Office of Budget, Finance and Award Management, including the Deputy Director for Large Facilities Projects, the Office of the General Counsel, the Office of Legislative and Public Affairs, the Office of International Science and Engineering and the Office of the Assistant Director for MPS.

U.S. LHC program management is performed through a Joint Oversight Group (JOG), created by the NSF and DOE. 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: CERN Project Management is making every effort to maintain the LHC extended schedule, which aims for first collisions in 2007, without significant delays. 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 construction 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 were scheduled for completion in FY 2005; final appropriations of MREFC construction funding were received in FY 2003. The U.S. ATLAS construction project, as of July 2005, was 96 percent complete, as measured by Earned Value. The U.S. CMS project was also 96 percent complete. Milestones for both projects have been 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 aimed for the completion of at least 97 percent of the U.S. deliverables by the end of FY 2005, the so-called CD-4A (Critical Decision) completion milestone, which was achieved, with the remaining items linked to the installation schedule.

Major remaining milestones for the NSF components of LHC are outlined below:

FY 2006 Milestones:
Continue ATLAS and CMS detector installation and testing in underground halls.

US ATLAS
Finish installation of Trigger and Data Acquisition system; and
Complete production of Muon Cathode Strip Chamber Readout.

US CMS
Complete delivery of Electromagnetic (EM) Calorimeter Optical Links;
Finish Trigger Installation;
Complete the ECAL Front-end electronics production; and
50 percent of Silicon Tracker Rods completed

FY 2007 Milestone:
First data taking using both ATLAS and CMS detectors.

Funding Profile: Funding for the overall LHC project, including the ATLAS and CMS detectors and the accelerator, is provided through an international partnership involving NSF, 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 $531 million, with $450 million from DOE and $81 million from NSF. NSF and DOE will jointly provide a total contribution of $331 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 in construction, although one NSF-supported group has recently joined the LHC-B experiment and is participating in monitoring and detector upgrade R&D.

LHC 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& Earlier	8.69		0.15	54.26			8.84	54.26	$63.10
FY 2002	1.60			16.90			1.60	16.90	$18.50
FY 2003				9.69	5.00		5.00	9.69	$14.69
FY 2004[1]					7.00		7.00	-	$7.00
FY 2005 Actual					10.51		10.51	-	$10.51
FY 2006 Plan					13.36		13.36	-	$13.36
FY 2007 Request					18.00		18.00	-	$18.00
FY 2008 Estimate					18.00		18.00	-	$18.00
FY 2009 Estimate					18.00		18.00	-	$18.00
FY 2010 Estimate					18.00		18.00	-	$18.00
FY 2011 Estimate					18.00		18.00	-	$18.00
FY 2012 Estimate					18.00		18.00	-	$18.00
Subtotal, R&RA	$10.29		$0.15		$143.87		$154.31		
Subtotal, MREFC		-		$80.85		-		$80.85	
Total, Each Stage		$10.29		$81.00		$143.87			$235.16

NOTE: The estimated operational lifespan of this project is approximately 20 years. Operations and Maintenance Estimates for FY 2008 and beyond are under negotiation with DOE. They are subject to the availability of funds and appropriate program balance and may not reflect actual budget requirements. For FY 2002 and earlier, R&RA funds totaling $4.59 million for Concept/Development were listed in the Operations and Maintenance in the budgets for FY 2006 and earlier. This has been corrected in the present table.

[1]As of FY 2004, start dates for projected NSF funding correspond to accelerated schedules to begin on: 8/1/04, 5/1/05, 2/1/06 and 11/1/06. Thereafter, funding will begin on November 1 of each year.

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

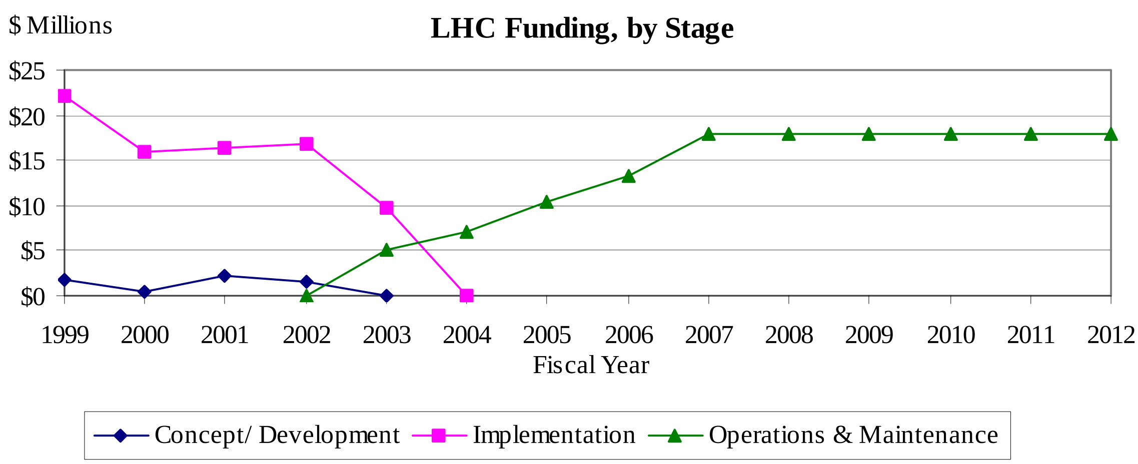
- Concept/Development: The LHC has been under discussion since FY 1989. NSF funding in FY 1996-99 supported technical design studies.

- 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 by the end of 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 was 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 & Operations: FY 1999-2008 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 2007 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 and maintenance 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.

Software and Computing: Both US ATLAS and US CMS are active members in the US Grid activity that is providing computing resources to several sciences in addition to the LHC collaborations. In addition, both collaborations have now selected their initial set of "Tier-2 centers" which are primarily funded by NSF to provide data analysis capabilities for university researchers.



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 million through individual PI awards once the facility reaches full operations. Both ATLAS and CMS have well-developed outreach activities (see Education Goals above).

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; Hanford has a second interferometer in the same housing. 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 on the order of one part in 10^{21}, meaning that the expected change in the apparent 4-km length is only on the order of 4×10^{-18} meters or about 1/1000th 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. The Phase I LIGO currently operating is close to its design specifications. The Advanced LIGO (AdvLIGO) upgrade, designed to reach best possible sensitivity for an earth-based instrument, is requested to begin construction in FY 2008. For more information on AdvLIGO, please see the Major Research Equipment and Facilities Construction (MREFC) chapter.

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. Furthermore, even though 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.

Aerial view of the LIGO facility in Hanford, WA. *Credit:* *www.ligo.caltech.edu*

Principal Education Goals: LIGO plays a significant role in the training of Ph.D. graduates for the country's workforce. Following the beginning of LIGO science runs in FY 2002, the number of graduate students has grown and will continue to do so. In addition, LIGO has a diverse set of educational activities at its different sites, activities that involve a large number of undergraduates (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. In FY 2004, LIGO received a large grant to build a Visitor Center at the Livingston, LA site that will be filled with Exploratorium exhibits and will be the focal point for augmenting teacher education at Southern University and other student-teacher activities state-wide through the Louisiana Systemic Initiative Program. Construction began on the center in early FY 2006.

Connections to Industry and to Other Federal Agencies: 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). LIGO is cooperating with the Defense Intelligence Agency on research on LIGO interferometers as impulse seismic event detectors.

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 also participates in the Physics Division Project Advisory Team, comprising staff from the Office of General Counsel, the Office of Legislative and Public Affairs, the Office of Budget, Finance and Award Management, including the Deputy for Large Facility Projects, and the Office of International Science and Engineering.

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. Four science runs have been performed: S-1, in the period from August 23, 2002 to September 9, 2002, with a sensitivity of about a factor of 100 from the design goal; S-2 lasted 59 days from February 14, 2003 to April 14, 2003, with a sensitivity of about a factor of 10 from the design goal; S-3 in the period from October 31, 2003 to January 8, 2004, with a sensitivity of about a factor of 3.5 from the design goal; and S-4 from February 22, 2005 to March 23, 2005. The improvements achieved in S-4 were remarkable. The addition of the Hydraulic External Pre-Isolation (HEPI) system to the Livingston interferometer to eliminate interference from anthropogenic noise sources was totally successful, as indicated in the improvement of the Livingston duty cycle from 21.8 percent in S-3 to 74.5 percent in S-4 leading to more than a 50 percent triple coincidence operation during the run. In addition, during S-4 all three interferometers showed high sensitivity, achieving levels within a factor of 2 of design sensitivity. Further improvements have culminated with the start of the long S-5 science run, which began on 4 November 2005 and is expected to last for eighteen months, operating with a sensitivity somewhat better than the design goal. The FY 2007 Request for LIGO is for $33 million. This funding level reflects work to develop improved detectors and full operations of LIGO to run their interferometers at sites at Hanford, WA and Livingston, LA in coincidence with each other and with gravitational wave detectors abroad.

The LIGO site in Livingston Parish, LA, was shut down in preparation for Hurricane Katrina, in accordance with established emergency preparedness procedures, and suffered very minor damage. The facility is participating in the S-5 science run with no loss of sensitivity.

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
(Obligated Dollars and Estimates in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		Grand Total
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	
FY 2001& Earlier	47.56		35.90	236.00	49.50		132.96	236.00	$368.96
FY 2002					28.00		28.00	-	$28.00
FY 2003					33.00		33.00	-	$33.00
FY 2004					33.00		33.00	-	$33.00
FY 2005 Actual					32.00		32.00	-	$32.00
FY 2006 Current Plan					31.68		31.68	-	$31.68
FY 2007 Request					33.00		33.00	-	$33.00
FY 2008 Estimate					26.55		26.55	-	$26.55
FY 2009 Estimate					26.78		26.78	-	$26.78
FY 2010 Estimate					24.42		24.42	-	$24.42
FY 2011 Estimate					23.70		23.70	-	$23.70
FY 2012 Estimate					20.94		20.94	-	$20.94
Subtotal, R&RA	$47.56		$35.90		$362.57		$446.03		
Subtotal, MREFC		-		$236.00		-		$236.00	
Total, Each Stage		$47.56		$271.90		$362.57			$682.03

NOTE: The expected operational lifespan of this project is about 20 years. The decreases beginning in FY 2008 reflect the initiation of construction of Advanced LIGO, scheduled to begin that year. LIGO activities will continue during the construction of AdvLIGO. These operations estimates are developed strictly for planning purposes and are based on current cost profiles; they will be updated as new information becomes available. For more information on future operations of the upgraded facility, please consult the MREFC chapter of this document.

Detailed 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 – $11.6 million (FY 1975-87); pre-construction R&D – $16 million (FY 1988-91); and ongoing R&D throughout construction – $20 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 management and operations (M&O) costs began phasing-in in FY 1997. Commissioning costs are included in LIGO operations through FY 2001. M&O funding includes operation for science and engineering runs and R&D for advanced detectors. Note that the M&O figures for LIGO in FY 2008 through FY 2012 are the same as those shown for AdvLIGO in the MREFC section.

Renewal or Termination: The cooperative agreement for the support of LIGO operations expires in FY 2006. NSF is planning to make a two-year extension to LIGO for FY 2007 and FY 2008 to continue operations, including the current extended science run, and to conduct research in preparation for Advanced LIGO.

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 2,000 students per year have taken advantage of this opportunity. More formal programs at the sites include participation in the Research Experiences for Teachers (RET) Program, a set of "scientist-teacher-student" research projects in support of LIGO, and participation in the Summer Undergraduates Research Fellowships/Research Experiences for Undergraduates (SURF/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 include information on research opportunities for schools and a set of standards-based classroom activities, lessons, and projects related to LIGO science. In FY 2004, NSF initiated a project to build a Visitor Center at the Livingston, LA site that will be filled with Exploratorium exhibits and that will be the focal point for augmenting teacher education at Southern University and other student-teacher activities state-wide through the Louisiana Systemic Initiative Program. Construction of the center began in early FY 2006. Outreach coordinators have recently been hired 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 40 collaborating institutions with over 500 participating scientists. A Memorandum of Understanding (MOU) between the LIGO Laboratory and each institution determines the role and membership responsibilities of each participating 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.

MREFC Facilities

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.

NSF believes that the highest priority within the MREFC account must be the current projects. To that end, the FY 2007 Budget requests funding for the Atacama Large Millimeter Array ($47.89 million); EarthScope ($27.40 million); the IceCube Neutrino Observatory ($28.65 million); the National Ecological Observatory Network ($12.0 million); the Scientific Ocean Drilling Vessel ($42.88 million); and the South Pole Station Modernization Project ($9.13 million). An additional $3.0 million is requested to reimburse the DOJ Judgment Fund for a settlement related to the Polar Aircraft Upgrades project. NSF's second priority are those projects that have received NSB-approval for inclusion in a budget request but which have not yet received funding. NSF is requesting funding for two new starts in FY 2007. In priority order, these are the Alaska Region Research Vessel ($56.0 million) and the Ocean Observatories Initiative ($13.50 million). Finally, NSF is requesting funding for one new start in FY 2008: Advanced LIGO ($28.48 million in FY 2008).

For additional information of projects funded through the MREFC account, please see the MREFC chapter of this document.

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-review 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 2005, its regional K-12 outreach efforts engaged over 6500 students from Florida and neighboring Georgia in 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 such as the advancement of conducting materials for magnets, including high quality Copper-Niobium micro-composite wires with outstanding characteristics (strength, conductivity, and resistive ratio) that are now available for the construction of high field coils. These technology projects cover the range of analysis, design, materials, component development and testing, coil fabrication, cryogenics, and system integration and testing.

The laboratory is involved in numerous consortia, as one of its mission objectives is "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 2004, the laboratory collaborated with 24 private sector companies, 12 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 educational and outreach activity reaches nearly 6,000 students, teachers and members of the general public. In addition, in 2005, the NHMFL launched a College Outreach-Workforce Initiative (CO-WIN) Program to broaden participation in the NHMFL programs. This has included outreach to around 200 undergraduates at Historically Black Colleges or Universities (HBCU's).

Management and Oversight: The NHMFL is operated for the NSF by a consortium of institutions comprised of 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 the facility was dedicated and opened 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 Affairs 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, 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, represents 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 is comprised of 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.

The National Facilities Program Director in NSF's Division of Materials Research (in MPS) has primary responsibility for NSF administration and oversight of the NHMFL 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.

Current Project Status: When first established in 1990, the primary emphasis of the NHMFL was magnet technology and development in order to provide high magnetic fields for users. An extensive suite of instrumentation for high-field research is now in place. Major projects completed include a continuous-field 45 Tesla hybrid magnet in operation since 2003 and a 900 Megahertz (MHz) ultra-wide-bore nuclear magnetic resonance (NMR) magnet open for use since July 2005. The NHMFL is now moving to a new phase with emphasis on service to users in combination with in-house and collaborative research and an extensive set of educational programs. The magnet technology activity has moved towards the development of new energy efficient magnets and to making high magnetic fields available at the nation's premier neutron and photon sources.

The FY 2007 Request for the NHMFL totals $26.50 million, including support for the National High Field Mass Spectrometry Facility (NHFMS) from the MPS Division of Chemistry.

Renewal or Re-Competition: NSF renewed support for the NHMFL in 1996 and again in 2001 following comprehensive external reviews. The current five-year cooperative agreement for the support of NHMFL operations was due to expire in FY 2005. In FY 2004, the National Science Board (NSB) approved a two-year extension through December 2007 "to allow time for a National Academy of Sciences panel to complete a report on high magnetic field science and technology and for the National Science Foundation (NSF) to convene a 'blue-ribbon' panel to recommend the best course of action concerning re-competition of the NHMFL." Both panels have now completed their work[1]. NSF is currently examining options for further support of the NHMFL either by renewal or through recompetition.

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 2001	6.20	13.80	$20.00
FY 2002	7.97	17.00	$24.97
FY 2003	6.50	17.43	$23.93
FY 2004	3.44	21.06	$24.50
FY 2005	3.83	21.67	$25.50
FY 2006 Current Plan	3.90	21.84	$25.74
FY 2007 Request	4.00	22.50	$26.50
FY 2008 Estimate	4.00	22.50	$26.50
FY 2009 Estimate	4.00	22.50	$26.50
FY 2010 Estimate	4.00	22.50	$26.50
FY 2011 Estimate	4.00	22.50	$26.50
FY 2012 Estimate	4.00	22.50	$26.50

The data are presented as being either implementation (permanent equipment) or operations and maintenance (non-permanent equipment). Estimates for FY 2008 and beyond are developed 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. Magnet Science and Technology has aggressively pursued several major magnet projects that are part of the NHMFL core mission to develop world-class magnet systems for high field research. The Ultra-Wide Bore 900 MHz NMR magnet is currently available to users through a competitive peer review process. There has been significant progress in the DC and pulse user magnet facilities in achievable field, bore, homogeneity and cooling time upgrades to the standard magnet systems. A construction proposal for the Series-Connected Hybrid (SCH) is currently under review by NSF. SCH will provide combined high DC field and high homogeneity at much lower power than current magnets. As the lead institution for magnet technology development, in FY 2004 the NHMFL designed and built a sweeper magnet for the National Superconducting Cyclotron Laboratory, undulator magnets for the Advanced Photon Source at Argonne National Laboratories, and quench protection of a crystal puller magnet for Duksung Corporation. In addition, the high temperature superconducting magnet and materials

[1]Information on these panels may be found on the following websites:
http://www.nsf.gov/attachments/102806/public/HighMagneticFieldsReport.pdf (a report of the NHMFL review panel lead by Dr. Robert Richardson on behalf of the MPS Advisory Committee); and
http://www7.nationalacademies.org/bpa/COHMAG_committee.html (a report prepared by the Committee on Opportunities in High Magnetic Field Science).

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. A conceptual engineering design proposal for a special high-field magnet for neutron scattering experiments at the Spallation Neutron Source is currently under review by NSF.

The NHMFL's Ion Cyclotron Resonsance (ICR) Program has two Fourier Transform-Ion Cyclotron Resonance (FT-ICR) mass spectrometers available to users. A 14.5 Tesla system is the highest field FT-ICR mass spectrometer in the world, and it is being used to attack a broad range of biological, drug discovery, and petrochemical problems that require ultrahigh resolution and extremely accurate mass. A 7 T FT-ICR mass spectrometer is dedicated to analysis of volatile mixtures (e.g., low boiling fractions of crude oil) and FT-ICR instrumentation development

- 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 and continues through 2007 has 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 and who 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.

Associated Research and Education Activities: The NHMFL base award currently includes approximately $240,000 per year in support of Research Experiences for Undergraduates (REU), and a wide variety of pre-college educational outreach and partnership activities with additional funding from the State of Florida. The REU program further supports the NHMFL CO-WIN program, which hosted 24 females, 2 Hispanics and 4 African-Americans among the 42 REU students in the 2004 and 2005 programs. In FY 2006 NHMFL was awarded $122,057 to continue a Research Experiences for Teachers (RET) activity in FY 2006 and 2007.

In FY 2005, educators at the Center for Integrating Research and Learning (an integral part of the NHMFL) provided in-class educational experiences for over 6600 students from 31 schools in nine counties and two states. The Center provided professional development opportunities for over 100 teachers through summer institutes, workshops, and conferences. In addition, tours of the NHMFL were provided to 970 members of the general public with 840 contact hours led by over 60 different guides. This gives rise to a total of more than 7000 students, teachers, and general public coming in contact with some facet of the NHMFL's educational programs.

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	1117
FY 2002	3,500	15	22	1319
FY 2003	6,841	21	19	226[c]
FY 2004	6,252	20	16	189
FY 2005[d]	7,000	20	12	200

[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]State of Florida eliminated funding for "Science, Tobacco and You" Program in 2003.

[d]The FY 2005 number of students receiving PhD's data is incomplete

In addition to the individuals included 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 2005, the NHMFL at FSU supported an average of 86 graduate students, 29 postdoctoral research associates, and 18 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, 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 individual users annually.

National Nanofabrication Infrastructure Network (NNIN)

Project Description: The National Nanotechnology Infrastructure Network (NNIN) comprises 13 university sites that form an integrated national network of user facilities supporting research and education in nanoscale science, engineering, and technology. The NNIN provides 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 predecessor five-university National Nanofabrication Users Network (NNUN), which successfully concluded after ten years of NSF support at the end of 2003.

Principal Scientific Goals: The NNIN's broad-based national user facilities 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 help stimulate technological innovation. The network also develops the infrastructure and intellectual and institutional capacity needed to examine and address societal and ethical implications of nanotechnology, including issues of environment, health, and safety.

Principal Educational and Outreach Goals: The NNIN undertakes 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 seeks to leverage its capabilities through connections and collaborations with national and industrial laboratories, and with foreign institutions. Through such 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 is 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 provides intellectual leadership for the network; is responsible, in cooperation with the Network Executive Committee, for developing strategies, operational plans, and coordination of the activities of the network; and serves as the principal contact on behalf of the network with the NSF. An external Network Advisory Board meets at least annually and provides 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 shares its major recommendations with the NSF. The Site Directors are 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 provides oversight to the NNIN under a cooperative agreement. The NNIN is reviewed through annual site reviews held at one of the network sites. In addition, a semi-annual review is held at the NSF attended by the Network Director and Executive Committee members. The program officer for the NNIN activity resides in the Division of Electrical and Communications Systems (in ENG). The program officer coordinates NNIN oversight with other Division and Directorate members of the NNIN working group. The working group consists of representatives from all NSF Directorates.

Current Project Status: The NNIN began operation under its award on March 1, 2004. The first comprehensive annual review of the NNIN was held following an initial 9 months of operation at the

Georgia Tech node in December 2004. The second annual review was held at the Austin, Texas node in February 2005. In part due to continuity provided by the five sites in the previous NNUN, and to the credit of the NNIN management team, the network already displays many of the attributes promised in the original vision from the proposal: a broad area of accessible micro- and nano- fabrication and characterization resources; a solid base of users with a significant representation from outside the host institutions including industrial and educational users; a strong research portfolio generated by the user community; positive initial performance at new sites with good plans in place to make them fully functioning nodes with solid user bases, including external users; and network-wide plans and efforts underway on educational outreach and societal and ethical implications of nanotechnology.

Funding Profile: The FY 2007 request is $13.89 million, $130,000 above the FY 2006 Current Plan of $13.76 million. Primary funding for NNIN is provided by ENG; additional funding is provided by all the Directorates in the Research and Related Activities account. The Directorate for Education and Human Resources provides support for NNIN in the amount of $200,000.

NNIN Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 2004		13.80	$13.80
FY 2005		13.90	$13.90
FY 2006 Current Plan		13.76	$13.76
FY 2007 Request		13.89	$13.89
FY 2008 Estimate		15.90	$15.90
FY 2009 Estimate		18.30	$18.30
FY 2010 Estimate		21.00	$21.00
FY 2011 Estimate		24.10	$24.10
FY 2012 Estimate		24.70	$24.70

NOTE: Data in FY 2004-2007 does not include $200,000 provided through the Advanced Technological Education program in the Directorate for Education and Human Resources. Estimates for FY 2008 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.

- Operations and Maintenance: The major portion of NSF funds provides 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. NSF may provide up to a 15 percent annual increase in budget beginning in FY 2008 should there be a need to cover anticipated growth in the user base, with related increased education, training and staffing costs; and enhanced instrumentation. NNIN has provided cumulative user data for its initial reporting year of March 2004-February 2005. The cumulative number of users for all 13 NNIN sites is 4,133. This includes academic users (3,560), small company users (423), and large company users (150). The number of graduate students conducting research at the facilities during the year was over 3,200, and the number of undergraduates was over 150. Over 1,700 scholarly publications resulted from users of the facilities.

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. Planned and ongoing NNIN educational contributions 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 (REU) program. In its second year of the REU program, 81 students participated. In FY 2006, the number of REU students will increase to 100.

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 U.S. 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 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 recently 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 three Associate Directors: one for Nuclear Science, one for Accelerator Research, and one for Operations. 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 Division (MPS) and other staff, accompanied by external experts. During the NSCL upgrade, NSF convened several technical panels to review cost, schedule, technical progress, and management of the project to monitor progress and maintain oversight.

Current Project Status: An experimental program using the recently completed coupled cyclotron facility is now underway. The FY 2007 Request for the NSCL totals $17.60 million, a slight increase over the the FY 2006 Current Plan of $17.32 million for FY 2006. This 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 2001	1.00	11.40	$12.40
FY 2002	0.40	14.41	$14.81
FY 2003		15.65	$15.65
FY 2004		15.65	$15.65
FY 2005 Actual		17.50	$17.50
FY 2006 Current Plan		17.32	$17.32
FY 2007 Request		17.60	$17.60
FY 2008 Estimate		18.00	$18.00
FY 2009 Estimate		18.00	$18.00
FY 2010 Estimate		18.00	$18.00
FY 2011 Estimate		18.00	$18.00
FY 2012 Estimate		18.00	$18.00

The current Cooperative Agreement expires in FY 2006. Operations estimates for FY 2008 and beyond have been developed based on current cost profiles and are not intended to reflect actual budget requirements. They will be updated as new information becomes available.

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

- Implementation: The facility was upgraded between 1996 and 2001 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. Activities include routine preventive maintenance of the two coupled NSCL cyclotrons carried out each quarter, including vacuum systems, RF power systems, beam transport systems, the helium refrigerator used to supply coolant for the superconducting cyclotrons, and miscellaneous subsystems. 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. The facility serves several hundred active users.

Renewal or Termination: The current cooperative agreement expires at the end of FY 2006. NSF expects to consider a proposal to renew the agreement at that time pending a satisfactory performance review.

Associated Research and Education Activities: The NSCL faculty has an excellent reputation for high quality instruction and innovation in the classroom. Several NSCL faculty members have received Michigan State University's prestigious Teacher Scholar Award. NSCL faculty members make effective use of technology to enhance active learning in large lecture courses commonly found at large research universities. They pioneered the CAPA (Computer-Assisted Personalized Assignment) program and developed it further into the Learning Online Network with CAPA (LON-CAPA), an open-source software system, free of licensing fees, which provides a shared pool of over 60,000 granular learning resources within the framework of a full-featured course management system. Faculty at over 30 colleges and universities worldwide participate in the creation and sharing of problems as well as of other educational resources. In addition, online learning materials from seven major science textbook publishers are available in connection with the adoption of their printed materials, and K-12 teachers from over 20 schools use LON-CAPA for their students. NSCL faculty have also pioneered the use of multi-media "virtual university" teaching technologies and offer several courses for long-distance learners over interactive websites.

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

NEES: The George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES)

Project Description: NEES is a national, networked simulation resource of 15 advanced, geographically distributed, shared use earthquake engineering research experimental facilities with teleobservation and teleoperation capabilities. NEES provides a national infrastructure to advance 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 infrastructure systems. Experimental facilities include shake tables, geotechnical centrifuges, a tsunami wave basin, large-scale laboratory experimentation systems, and mobile and permanently installed field equipment. NEES facilities are located at academic institutions (or at off-campus field sites) throughout the United States, networked together through a high performance Internet2 cyberinfrastructure system. NEES completed construction on September 30, 2004, and opened for user research and education projects on October 1, 2004. NEES is currently operated by the non-profit corporation NEES Consortium, Inc. (NEESinc), headquartered in Davis, California. Through an initial five-year cooperative agreement with NSF (FY 2005 – FY 2009), NEESinc operates the 15 experimental facilities; the NEES cyberinfrastructure center; coordinates education, outreach, and training; and develops national and international partnerships.

Researchers at the University of California, San Diego, in partnership with industry, use the largest outdoor shake table in the U.S. as part of NEES to test the tallest building structure ever on a shake table. This seven-story, 65-foot tall, reinforced concrete structure is being tested to investigate "promising new designs that might improve the earthquake safety of apartment and condominium buildings and other residential structures in densely populated and seismically active regions in Los Angeles and Southern California." Credit: *Professor José I Restrepo, Department of Structural Engineering, University of Californa, San Diego*

Principal Scientific Goals: NEES' broad-based national research facilities and cyberinfrastructure enables new discovery and knowledge through capabilities to now test more comprehensive, complete, and accurate models of how civil infrastructure systems respond to earthquake loading (site response, soil-foundation-structure interaction, tsunami effects, and structural and nonstructural response). This enables the design of new methodologies, modeling techniques, and technologies for earthquake hazard mitigation.

Principal Education Goals: NEES engages 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. NEES has developed an education, outreach and training strategic plan to develop a broad spectrum of education and human resource development activities with special emphasis on non-traditional users and underrepresented groups.

Partnerships and Connections to Industry: Through the Congressionally mandated National Earthquake Hazards Reduction Program (NEHRP), the Federal Emergency Management Agency (FEMA), the National Institute of Standards and Technology (NIST), NSF, and the U.S. Geological Survey (USGS) support research related to earthquake hazard mitigation. Connections to industry include private engineering consultants and engineering firms engaging in NEES research or using data and models developed through NEES. NEES is leveraging and complementing its capabilities through connections and collaborations with large testing facilities at foreign earthquake-related centers, laboratories, and institutions. NSF and NEESinc have recently developed partnerships to utilize the NEES infrastructure with the 3-D Full-Scale Earthquake Testing Shake Table Facility (E-Defense), built by the Japanese National Research Institute for Earth Science and Disaster Prevention (NIED) and operational in 2005. To facilitate NEES/E-Defense collaboration, in August 2005, NEESinc and NIED signed a Memorandum of Understanding, and in September 2005, NSF and the Japanese Ministry of Education, Culture, Sports, Science, and Technology signed a Memorandum Concerning Cooperation in the Area of Disaster Prevention Research. Through such partnerships and joint meetings and workshops, NEES shares its expertise in testing and cyberinfrastructure, provides specialized training opportunities, and coordinates access to unique testing facilities and the central data repository.

Management and Oversight: Through a NSF cooperative agreement, NEESinc operates the 15 experimental facilities and the NEES cyberinfrastructure center; coordinates education, outreach, and training; and develops national and international partnerships. As a non-profit corporation, NEESinc operates under its own governance structure and is overseen by a Board of Directors elected from its membership in accordance with its by-laws. Day-to-day operations of NEESinc is overseen by its headquarters staff that is led by an Executive Director. Each experimental facility has an on site director responsible for local day-to-day equipment management, operations, and interface with NEESinc, other NEES facilities, users, and the NEES cyberinfrastructure center for network coordination. The NEES cyberinfrastructure center maintains the telepresence, data, collaborative, simulation, and other related services for the entire NEES network.

NSF provides oversight to NEES operations through a cooperative agreement with NEESinc. NEES operations are reviewed through annual site visits. The NSF program manager for NEES is located in the Civil, Mechanical and Manufacturing Innovation (CMMI) Division in the Directorate for Engineering (ENG). The NSF Deputy Director for Large Facility Projects in the Office of Budget, Finance, and Award Management provides advice and assistance.

Current Project Status: NEES completed its primary construction activities at the end of FY 2004. About $2.7 million in remaining FY 2004 MREFC funds was used to fund construction of deferred capabilities for NEES. This included four new capabilities for system integration (cyberinfrastructure), completed on September 30, 2005, and new capabilities at 13 experimental facilities, to be completed by September 30, 2006.

Through annual program solicitations and Small Grants for Exploratory Research, CMMI has funded 26 research projects to utilize the NEES facilities. In FY 2007, $15.0 million will be used to support basic research in multi-hazard engineering involving experimental and theoretical simulations at the NEES facilities, addressing important challenges in earthquake and tsunami engineering research.

Funding Profile: NSF received $7.70 million in FY 2000 to initiate construction of NEES. Total MREFC funding for this project was $81.76 million during FY 2000-04, with an additional $1.10 million provided to the project through the Experimental Program to Stimulate Competitive Research through the Education and Human Resources (EHR) account.

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 1998 & Earlier	0.26							$0.26	-	-	**$0.26**
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				8.05				-	$8.05	-	**$8.05**
FY 2005						17.94		$17.94	-	-	**$17.94**
FY 2006 Current Plan						20.31		$20.31	-	-	**$20.31**
FY 2007 Request						21.27		$21.27	-	-	**$21.27**
FY 2008 Estimate						22.17		$22.17	-	-	**$22.17**
FY 2009 Estimate						23.02		$23.02	-	-	**$23.02**
FY 2010 Estimate						23.57		$23.57	-	-	**$23.57**
FY 2011 Estimate						23.57		$23.57	-	-	**$23.57**
FY 2012 Estimate						24.16		$24.16	-	-	**$24.16**
Subtotal, R&RA	$0.70		$0.00			$176.02		$176.72			
Subtotal, MREFC		$0.39		$81.37			$0.00		$81.76		
Subtotal, EHR					$1.10					$1.10	
Total, Each Stage		**$1.09**			**$82.47**		**$176.02**				**$259.58**

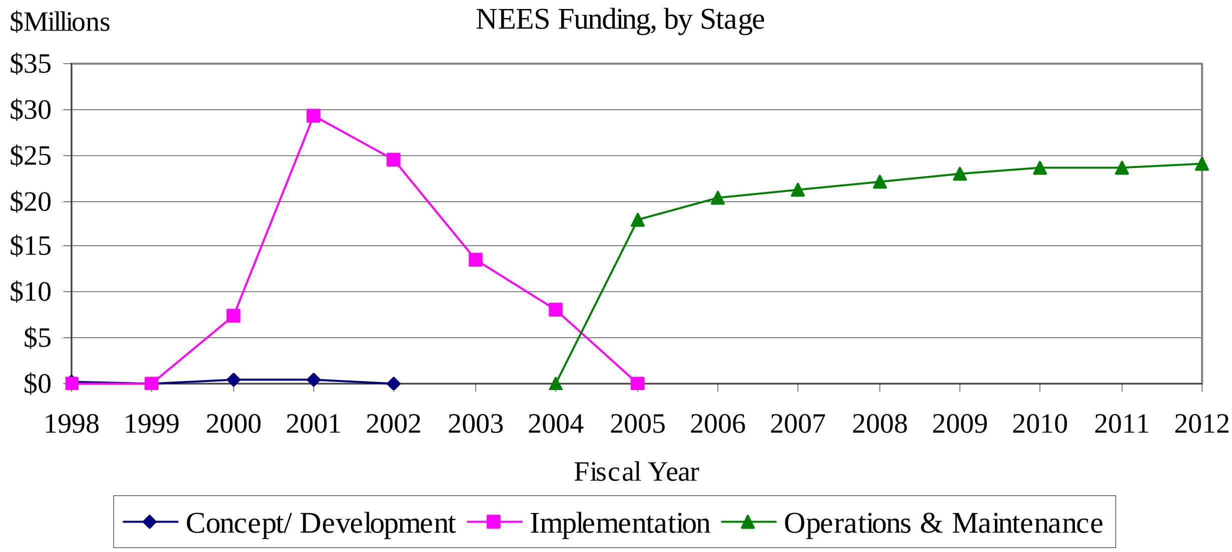
NOTE: The expected operational lifespan of this project is 10 years, from FY 2005 to FY 2014. NEES operations for FY 2005 – FY 2009 was approved by the National Science Board in May 2004 for up to $106.52 million total; approximately $21.3 million annually. Operations estimates for FY 2010 and beyond 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 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 funded an international workshop to foster long term working relationships for experimental earthquake engineering research and national workshops and studies 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 supported a range of equipment acquisition, as well as system integration and consortium development. To encourage the broadest participation for establishment of geographically distributed NEES experimental facilities, 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 major construction period in FY 2004, NEES entered its 10-year operational period through FY 2014. NEESinc provides the leadership, management, and coordination for operations of all the NEES shared use resources and establishes a broad and integrated partnership that includes participation of the full membership of the earthquake engineering community, both within the U.S. and abroad. NEESinc provided 2877 shared use days during its initial FY 2005 reporting period. As an internet-based resource, access to the NEES network is 24/7 to anyone with Internet capabilities. The NEES experimental facilities are utilized annually for research by the broad earthquake engineering community as well as by personnel at the host institutions of the 15 NEES facilities.



Renewal or Termination: The initial five-year NEES operations award may be renewed once for an additional five years, subject to satisfactory review of performance and availability of funds. The maximum duration of this award is ten years.

Science Support: Along with direct operations and maintenance support for NEES, NSF provides support for research conducted at NEES experimental facilities through ongoing research and education programs. The NEES cyberinfrastructure also provides a platform for the earthquake engineering community as well as other communities to develop new tools for shared cyberinfrastructure. In addition, NSF has initiated grand challenge, small group, and individual investigator research projects that utilize the NEES experimental facilities, data, and computational resources to comprehensively address major research questions in earthquake engineering and seismic hazard mitigation. The annual support for such activities is estimated to be $15.0 million in FY 2007.

Other Facilities

Other Facilities support, $15.26 million in FY 2007, includes continued support for the continued phase-out of program and contract activities for the Ocean Drilling Program. Other items within this category include facilities for physics and materials research.

POLAR FACILITIES AND LOGISTICS

Antarctic Facilities and Logistics

Project Description: Antarctic Facilities and Operations provides 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, 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. The U.S. Antarctic Program also provides environmental stewardship and maintains U.S. presence in Antarctica in accord with U.S. policy.

The Earth Station behind Palmer Station provides a communication link via the 5 meter diameter antenna that sees a satellite orbiting the equator, allowing people to make phone calls and use the Internet, as well as providing the remote station with telemedicine capability.

Principal Education Goals: By maintaining and operating the three U.S. stations in Antarctica, Antarctic Facilities and Operations supports 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: There are approximately 385 separate subcontractors for supplies and technical services. The U.S. Antarctic Program prime support contractor is Raytheon Polar Services Company (RPSC).

Management and Oversight: The Office of Polar Programs (OPP) has 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 Division of 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 oversight and direction of South Pole Station Modernization, an activity funded out of the Major Research Equipment and Facilities Construction (MREFC) account since FY 1998. The new station will provide the infrastructure required for imaginative new research only possible at the South Pole.

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 is discussed in the MREFC chapter.

Antarctic Facilities and Operations Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 2001		117.96	$117.96
FY 2002		126.15	$126.15
FY 2003		143.93	$143.93
FY 2004		147.04	$147.04
FY 2005		155.73	$155.73
FY 2006 Current Plan		199.96	$199.96
FY 2007 Request		218.09	$218.09
FY 2008 Estimate		224.60	$224.60
FY 2009 Estimate		231.30	$231.30
FY 2010 Estimate		238.20	$238.20
FY 2011 Estimate		245.30	$245.30

NOTE: 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.
Beginning in FY 2006, Antarctic facilities and operations support includes estimates for NSF to assume the responsibility, from the U.S. Coast Guard, for funding the costs of icebreakers needed for the support of scientific research in polar regions.

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. The contractor is selected through a competitive bidding process. Rotary- and fixed-wing aircraft used in support of research are provided through additional competitively awarded contracts. 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 has exercised its option to extend the performance period through 2010.

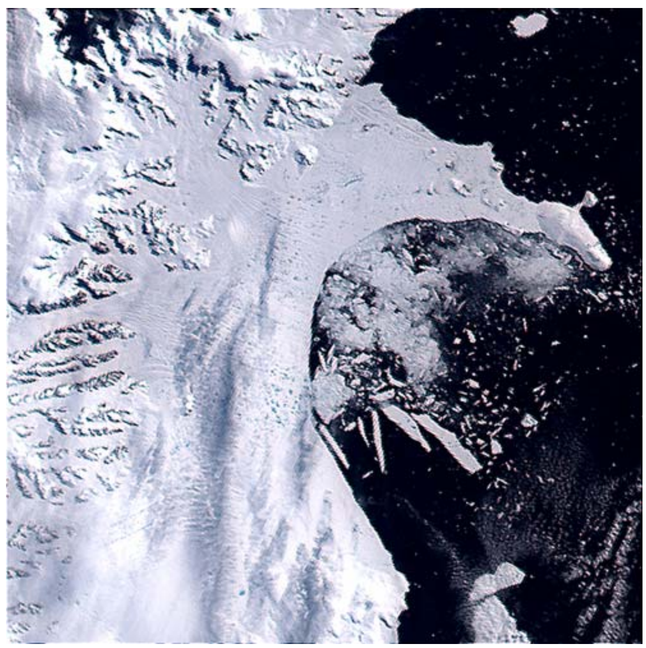
Associated Research and Education Activities: The Antarctic infrastructure makes science in Antarctica possible - ranging from astrophysics to microbiology and climatology - and also provides infrastructure supporting education and outreach activities. The U.S. Antarctic Program infrastructure and scientific activity also maintains a U.S. presence in Antarctica in accordance with U.S. policy. Research is funded through NSF’s Antarctic Research Grants Program and through other federal agencies funding research in Antarctica. A major focus of research and education activity in FY 2007 and FY 2008 in the polar regions will be the International Polar Year (IPY).

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 responds 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. The current contract with VECO USA to provide research support and logistics services for NSF-sponsored activities in the Arctic was recompeted and awarded in January 2005. The contract has an initial term of four years and three one-year extensions excercised on the basis of performance. Additional major support 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; and development of a network of strategically placed U.S. Long-Term Ecological Research Observatories linked to similar efforts in Europe and Canada.

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 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 resupply of McMurdo Station; fuel purchased from the Defense Logistics Agency; and use of Department of Defense satellites for communications.



One of a series of satellite images of the Antarctic Penninsula that recorded the catastrophic break-up of a massive portion of the Larsen B ice shelf – an area larger than Rhode Island – in 2002. *Credit: USAP*

NSF is requesting $112.42 million for Polar Logistics, an increase of $10.56 million from the FY 2006 Current Plan of $101.86 million. Arctic Research Support and Logistics increases to $44.90 million, and will provide infrastructure critical to supporting IPY as well as 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; and continuing support for a cooperative agreement with the Barrow Arctic Science Consortium. Support provided by DoD for the U.S. Antarctic Logistics program increases from $66.66 million in FY 2006 to $67.52 million in FY 2007.

Polar Icebreakers

With the FY 2006 Budget Request, NSF assumed the responsibility, from the U.S. Coast Guard, for funding the costs of icebreakers that support scientific research in polar regions. The FY 2007 Request for support of this activity is $57.0 million.

FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS

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 and serves over 250 users annually. 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.

The Gregorian Dome housing the telescope's feed optics and detectors is suspended 450 feet above the main reflector of the Arecibo radio telescope. With its diameter of 305 m (1000 feet), the main reflecting dish covers almost twenty acres and makes Arecibo the largest telescope on the planet.

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 NRAO, Penn State and other universities, and the Angel Ramos Foundation of Puerto Rico (a private organization).

Management and Oversight: Management is via 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. Arecibo Visiting Committee meetings (commissioned by Cornell) are attended by the NSF program manager, and committee reports are made available to NSF. Yearly status reports and long-range plans are presented by NAIC/Cornell representatives in 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: A solicitation for the management of NAIC was issued in November 2003. Two proposals were received. The proposal from Cornell was deemed to be superior and was approved for funding by the NSB at its March 2005 meeting. A new cooperative agreement is now in effect. The FY 2007 Request for NAIC totals $12.16 million, level with the FY 2006 Current Plan.

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[1]
FY 2001	1.10	9.00	$10.10
FY 2002		11.00	$11.00
FY 2003		12.63	$12.63
FY 2004		12.32	$12.32
FY 2005 Actual		12.42	$12.42
FY 2006 Current Plan		12.16	$12.16
FY 2007 Request		12.16	$12.16
FY 2008 Estimate		12.16	$12.16
FY 2009 Estimate		12.16	$12.16
FY 2010 Estimate		12.16	$12.16
FY 2011 Estimate		12.16	$12.16
FY 2012 Estimate		12.16	$12.16

NOTE: Total budget includes funding from both MPS/AST and GEO/ATM. In FY 2007, $10.46 million is provided from AST and $1.70 million from ATM. Operations budgets for FY 2008 and beyond are placeholders only. Budgets will be established based on the outcome of a review of AST facilities portfolio in 2005-2006.

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 usable bandwidth.

- Operations and Maintenance: Funding for management, operations and maintenance primarily maintains and utilizes existing facilities and develops new instrumentation in support of research by the national astronomical community. 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). The planetary radar program was funded by NASA until FY 2005 and is now incorporated in the base NAIC budget.

Renewal or Termination: On October 1, 2005, a new 54-month cooperative agreement with Cornell University went into effect.

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 Learning Center (both built with funding from the Angel Ramos Foundation of Puerto Rico). Arecibo attracts roughly 120,000 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.

Science Support: In addition to the funds listed above, approximately $70,000 per year is provided for the REU activities from the Program for Education and Special Programs in the Division of Astronomical Sciences (in MPS) and the Division of Atmospheric Sciences (in GEO). 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 NAIC. Many users are supported through NSF or NASA grants which pursue scientific programs that require use of NAIC.

National Center for Atmospheric Research (NCAR)

Project Description: National Center for Atmospheric Research 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; 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) that 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 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 decisions makers. One way this is achieved is via 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.

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 45 years. Notable recent examples include the community models, extensive collaboration with university partners (e.g., 748 peer-reviewed papers in FY 2004 that were co-authored by NCAR and university-based scientists), and extensive collaboration with non-academic scientists nationally and internationally.

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.

Management and Oversight: NCAR is managed by the University Corporation for Atmospheric Research (UCAR), a university-governed and university-serving organization comprised of over 69 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, DOD, 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 the Division of Contracts and Complex Agreements (DCCA), provide 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 2," in FY 2006 NCAR is embarking on a plan to implement 5 strategic goals and priorities that collectively have a wide range in scientific scope. Examples include explaining how the Earth system functions and accurately predict how it is likely to evolve and provide robust, accessible, and well-integrated information services and tools for research, analysis, and education. By connecting the strategic goals, plans, and accomplishments, the NCAR annual report (http://www.nar.ucar.edu/) provides an summary of the full life-cycle of the research, facilities, and educational activities that have taken place in FY 2005.

In addition, NCAR has managed the acquisition of the Major Research Equipment and Facilities Construction (MREFC) project High-Performance Instrumented Airborne Platform for Environmental Research (HIAPER). A highly modified and FAA certified Gulfstream G-V aircraft, HIAPER begins full scientific operations research at in the first quarter of calendar year 2006. HIAPER will be operated and maintain by NCAR. Operation of HIAPER is estimated at approximately $5.0 million annually.

NCAR 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 2002	3.75	73.84	$77.59
FY 2003	4.50	76.30	$80.80
FY 2004	4.61	78.31	$82.92
FY 2005	4.73	75.95	$80.68
FY 2006 Current Plan	4.85	78.51	$83.36
FY 2007 Request	4.97	81.88	$86.85
FY 2008 Estimate	4.30	83.00	$87.30
FY 2009 Estimate	4.44	85.00	$89.44
FY 2010 Estimate	4.58	87.00	$91.58
FY 2011 Estimate	4.55	89.00	$93.55
FY 2012 Estimate	4.69	91.00	$95.69

NOTE: MPS contributions for statistics and modeling are included. Operations estimates for FY 2008 and beyond have been developed based on current cost profiles and are not intended to reflect actual budget requirements. 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 for upgrades of various facets of NCAR's Mesa Lab facilities such as handicap accessibility, wiring systems, structural, and utilities upgrades.

- 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 is being performed; funding levels beyond FY 2006 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 schoolchildren or citizens come to visit the Mesa Laboratory. Lectures and demonstrations are also provided for visiting students and teachers. In FY 2005, there were 637 guided tour groups involving 12,727 visitors on scheduled tours of which 8,623 were in the K-12 group, 241 were college or graduate students, and approximately 60,000 adults from the general public. The significant increase in visitors is directly attributable to the major upgrade in the Mesa Laboratory informal science displays. 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. In addition, NCAR's education and outreach (EO) program maintains a website Windows to the Universe (www.windows.ucar.edu/, a bi-lingual English/Spanish website) and other EO websites which have K-12 as their primary audience. These sites touch many students with over 10,386,330 user sessions, involving 83,415,577 pages served.

Direct Impact of NCAR's Participation in Education Activities

Year	**K-12**	**Undergrad**	**Graduate**	**Teachers**
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]
FY 2004	8,505	*81*	*125*	1,381
FY 2005	13,723[c]	*92*	*135*	1,510

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.

[c] Includes public visits to Mesa Lab throughout year and special events: Super Science Saturday and 2 Wild Bear Science Saturdays, Earth Day: (4,100 attendance)

Science Support: NSF-supported researchers with grants totaling approximately $25 million per year used the aircraft and observational facilities operated by NCAR in FY 2005. This support comes from programs within the Atmospheric Sciences Division (in GEO) for proposals submitted for use of the NCAR aircraft 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 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.

National Optical Astronomy Observatories (NOAO) and the National Solar Observatory (NSO)

Project Description: NOAO 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 is the gateway for the U.S. astronomical community to 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. In addition, NSO provides routine synoptic solar data used by many researchers and other agencies. The NSO operates facilities in Sunspot, New Mexico and Tucson, Arizona as well as a coordinated worldwide network of six telescopes (GONG) specifically designed to study solar oscillations. As national facilities, NOAO and NSO telescopes are open to all astronomers regardless of institutional affiliation on the basis of peer-reviewed observing proposals and serve over 1,000 users annually.

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

Principal Education Goals: NOAO promotes and enhances 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: (1) 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; (2) the Teacher Leaders in Research-Based Science Education (TLRBSE), a summer workshop for middle and high school teachers; and (3) Astronomy from the Ground Up, a program for professional development of informal science educators from small- and moderate-size science centers nationwide.

Partnerships and Connections to Industry: Thirty-two U.S. member institutions and seven international affiliate members comprise the Member Institutions of the Association of Universities for Research in Astronomy (AURA), Inc., the management organization for NOAO and NSO. 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.

An aerial image of the Cerro Tololo Interamerican Observatory in Chile, taken after the dome of the Blanco 4-meter telescope was silvered early in 2001. *Credit: NOAO/AURA*

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 that are submitted to NSF. NSF conducts periodic reviews of AURA management by external committees. Ongoing oversight and evaluation is by an assigned NSF program director in the Astronomy Division (AST) in the Directorate for Mathematical and

Physical Sciences (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 competed and awarded to AURA October 1, 2002. A management review will be carried out this year, 3.5 years into the current cooperative agreement. The FY 2007 Request for base operations for NOAO and NSO totals $34.55 million, level with the FY 2006 Current Plan. Two community instrumentation programs are also administered by NOAO; these are increasing by $3.14 million, bringing the NOAO/NSO total to $40.05 million, up from the FY 2006 Current Plan of $36.91 million. The Telescope System Instrumentation Program (TSIP), totaling $4.0 million in the FY 2007 Request, an increase of $2.0 million over the FY 2006 Current Plan, is a program to unify the privately held and the national optical and infrared 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. The Adaptive Optics Development Program (AODP) totals $1.50 million in the FY 2007 Request, increasing $1.14 million over its FY 2006 Current Plan level.

NSO is nearing the completion of the design and development phase for the Advanced Technology Solar Telescope, which entered the 'readiness' phase for MREFC funding in late FY 2005. NOAO is also actively participating in the development of 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 National Research Council's Astronomy and Astrophysics Survey Committee.

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

NOAO and NSO Funding Profile

(Dollars in Millions)

	TSIP	AODP	NOAO and NSO Base Operations and Maintenance	Total, NSF
FY 2001			31.20	$31.20
FY 2002	4.00		32.82	$36.82
FY 2003	4.00	3.00	32.64	$39.64
FY 2004	4.00	3.00	34.35	$41.35
FY 2005	2.00	1.20	34.74	$37.94
FY 2006 Current Plan	2.00	0.36	34.55	$36.91
FY 2007 Request	4.00	1.50	34.55	$40.05
FY 2008 Estimate	4.00	1.50	34.55	$40.05
FY 2009 Estimate	4.00	1.50	34.55	$40.05
FY 2010 Estimate	4.00	1.50	34.55	$40.05
FY 2011 Estimate	4.00	1.50	34.55	$40.05
FY 2012 Estimate	4.00	1.50	34.55	$40.05

NOTE: The current cooperative agreement expires in FY 2007. Funding for FY 2008 and beyond are placeholders only. Budgets will be established based on the outcome of a review of AST facilities portfolio in 2005-2006.

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

- Implementation: 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 and the dedication of the Southern Astrophysical Research (SOAR) 4.1 m telescope in April 2004. SOAR commissioning is nearing completion and limited scientific observing has begun.

- 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 9 percent of the total budget.

Renewal or Termination: The current cooperative agreement expires at the end of FY 2007. A management review will be carried out this year, 3.5 years into the current cooperative agreement, on the basis of which NSF will decide whether to renew or recompete the program. Funding amounts for FY 2008 and beyond will be determined based on the outcome of a review of AST facilities portfolio in 2005-2006.

Associated Research and Educational Activities: Teacher training includes participation of more than 160 teachers in Project ASTRO, which directly impacts nearly 6000 students in the Tucson area; intensive (multi-week) training of about 25 teachers per year through Teacher Learning through Research Based Science Education; and Research Experiences 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 Science and Math (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. NOAO hosts the "Astronomy Education Review," a refereed, on-line journal (http://aer.noao.edu) that disseminates information about astronomy and space science education. Observational facilities are also used by approximately 200 graduate students each year and by undergraduate students participating in the Research Experiences for Undergraduate (REU) program, university-sponsored research, and the Practicas de Investigacion de Astronomia program (Chile).

Science Support: In addition to the funds listed above, approximately $500,000 per year is provided in total from EHR, the Program for Education and Special Programs in the Astronomy Division (REU and teacher enhancement) (MPS), and the Office of International Science and Engineering (REU). 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: NRAO 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. NRAO is also the North American executing organization for the international ALMA project. 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, and annually serve over 1,500 users worldwide.

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, as well as the design, construction, test and implementation of innovative scientific instruments and telescopes for radio astronomy and of software tools for 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, 2,000 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.

The Very Large Array, pictured here, consists of 27 radio antennas in a Y-shaped configuration on the Plains of San Agustin fifty miles west of Socorro, New Mexico. Each antenna is 25 meters (82 feet) in diameter. The data from the antennas is combined electronically to give the resolution of an antenna 36km (22 miles) across, with the sensitivity of a dish 130 meters (422 feet) in diameter.

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 monthly, quarterly, and annual reports submitted to NSF. NSF conducts periodic reviews of AUI management using external committees. Ongoing oversight and evaluation is by an assigned NSF program director in the Division of Astronomical Sciences (in 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 present cooperative agreement was extended through the end of FY 2009 by action of the National Science Board in December 2005. The VLA is undergoing an upgrade of its electronics and communications systems to significantly enhance its capabilities. The upgrade, referred to as Phase I of the Expanded Very Large Array (EVLA), is being carried out with NRAO funding. The NRAO is also engaged in construction of 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 2007 Request for NRAO totals $50.74 million, level with the FY 2006 Current Plan. The FY 2007 request includes an increase of $2.0 million for early ALMA operations for a total of $6.0 million.

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 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	9.34	45.64	$54.98
FY 2005	6.34	40.69	$47.03
FY 2006 Current Plan	5.00	45.74	$50.74
FY 2007 Request	5.00	45.74	$50.74
FY 2008 Estimate	4.32	46.42	$50.74
FY 2009 Estimate	4.32	46.42	$50.74
FY 2010 Estimate	4.32	46.42	$50.74
FY 2011 Estimate	4.32	46.42	$50.74
FY 2012 Estimate	4.32	46.42	$50.74

The current cooperative agreement expires in FY 2009. Operations budgets for FY 2008 and beyond are placeholders only. Budgets will be established based on the outcome of a review of AST facilities portfolio in 2005-2006.

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 an upgrade to the 25-year-old Very Large Array (VLA) radio telescope located in New Mexico that will enhance the capabilities of the current VLA. This upgrade is referred to as Phase I of 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: While ALMA construction is funded through the MREFC account, as elements of the facility take form, operations and maintenance must begin. The funding profile for the ALMA activity includes early operations funding beginning in FY 2005 at $1.0 million and increasing to $6.0 million in FY 2007. These amounts are included in the NRAO O&M figures above.

Renewal or Termination: The present cooperative agreement was extended to the end of FY 2009 with approval by the NSB in December 2005.

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 Research Experiences for Undergraduates (REU) program.

Science Support: In addition to the funding listed above, approximately $500,000 per year is provided in total from the Directorate for Education and Human Resources 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.

Recent Research Highlights

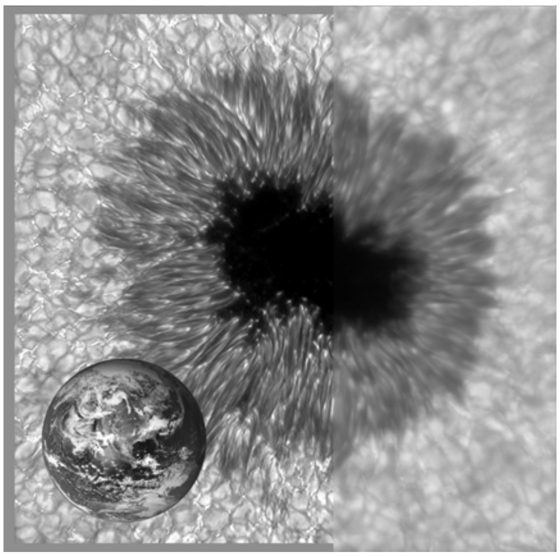
Image Courtesy of the American Physical Society

► **Catch a Wave from Space:** A new NSF-supported project called Einstein@Home permits members of the general public to participate in cutting-edge space research on their personal computers. The project reaches out through the Internet and harnesses those computers by the thousands to search through data from the Laser Interferometer Gravitational wave Observatory (LIGO) in the United States, and from the GEO 600 gravitational wave observatory in Germany. The goal is to find gravitational wave signals coming from extremely dense, rapidly rotating objects such as quark stars or neutron stars. If some of these compact stars are not perfectly spherical—which scientists believe is a distinct possibility—then the objects should emit characteristic gravitational waves that LIGO and GEO 600 may begin to detect in coming months. Einstein@home is a close collaboration between gravitational physicist Bruce Allen of the LIGO Scientific Collaboration group at the University of Wisconsin, Milwaukee, and the computer scientists who developed the software for a somewhat similar NASA program called SETI@home. LIGO, an NSF flagship project, is a crucial component of the U.S. participation in the World Year of Physics, a worldwide effort in education and outreach, based on Einstein's revolutionary discoveries in 1905. (MPS/PHY)

► **HIAPER Puts Atmospheric Research Above and Beyond**
NSF has provided a long-awaited way to take earth, environmental and atmospheric research to new heights. Last fall, a custom-designed aircraft called HIAPER (High-performance Instrument Airborne Platform for Environmental Research) was launched for its first operations to test onboard systems in a true research environment. The $81.50 million twin-engine airplane, outfitted with a unique suite of special instruments and sampling devices, can fly at the rarely studied boundary between the lower atmosphere and the stratosphere. Able to fly for thousands of miles while carrying a 5,600-pound payload of sophisticated research equipment, HIAPER is the most advanced aircraft research platform in the United States. (GEO/ATM)


Credit: Gemini Observatory

► **Detailed Views of the Large Magellanic Cloud** This cloudy tempest, known as the N44 superbubble complex, is dominated by a vast bubble about 325 by 250 light-years across. A cluster of massive stars inside the cavern has cleared away gas to form a distinctive mouth-shaped hollow shell. While astronomers do not agree on exactly how this bubble has evolved for up to the past 10 million years, they do know that the central cluster of massive stars is responsible for the cloud's unusual appearance. It is likely that the explosive death of one or more of the cluster's most massive and short-lived stars played a key role in the formation of the large bubble. The image provides one of the most detailed views ever obtained of this relatively large region in the Large Magellanic Cloud, a satellite galaxy to the Milky Way. (MPS/AST)



Credit: Friedrich Woegner, Kiepenheuer-Institut fur Sonnenphysik and Chris Berst, Mark Dosma, NSO/AURA/NSF

► **High Resolution Images of the Sun** Advanced adaptive-optics technologies now available at the National Solar Observatory's Dunn Solar Telescope at Sunspot, NM, are revealing striking details on the surface of the Sun. Such ultra-high resolution images should greatly improve our understanding the causes of solar flares, the explosive eruptions that eject high-energy particles into space and cause "solar storms" in the vicinity of Earth. Because these storms can adversely affect communications, electrical transmission lines, earth-orbiting satellites, and the safety of astronauts, better forecasting is critical. This sunspot image, spanning an area more than three times wider than Earth, is built from a series of 80 individual images, each 1/100th of a second long. taken over a period of 3 seconds. The right-hand side is an uncorrected view, while the left-hand side shows the effect of adaptive optics Superimposed on these images and on the same scale is an image of the Earth. (MPS/AST)

► **MoNA: Involving Undergraduates in Detector Construction:** Undergraduates at nine different colleges and universities – including several undergraduate-only institutions – are carrying out the bulk of the construction and testing on the Modular Neutron Array (MoNA): a new detector designed to observe high energy neutrons produced by experiments at the National Superconducting Cyclotron Laboratory at Michigan State University.

Credit: NSCL, University of Michigan

The detector itself will be seven times more efficient at single neutron detection than the laboratory's existing detectors, and will therefore represent a significant advance in the NSCL's ability to investigate the properties of exotic, neutron-rich nuclei. The participation of the undergraduates means that MoNA will also have tremendous educational and training benefits. The students will learn the basic principles of scintillator and photomultiplier tube operation, extraction of position information from fast electronic timing techniques, and detector calibration procedures. They will learn about the various kinds of nuclear physics experiments that will make use of this multi-detector array. And they will ultimately have the opportunity to participate in the assembly of the complete array at the NSCL, then see their work as part of a larger collaboration producing cutting-edge science in nuclear physics experiments. (MPS/PHY)

► **Learning from the Tsunami** Soon after the December 2004 Asian earthquake and tsunami, more than 15 NSF-supported reconnaissance teams mobilized to collect data on its impact and effect on roads, buildings and communities. New technologies made it possible to collect, organize, and preserve perishable field data not able to be captured following previous tsunamis. Scientists and engineers can now analyze the data stored in the NSF-supported archive to design strategies to lessen damage and loss of life from future disasters. This archive will allow researchers to easily re-examine and re-analyze the data using the latest technologies, which may lead to innovative discoveries.

Damage from the Great Sumatran Earthquake and Tsunami along India's coastline. *Credit: Professor Toshitaka Katada, Gunma University, Japan*

The Network for Earthquake Engineering Simulation (NEES) consortium is also developing a tsunami data repository. The consortium manages the cyberinfrastructure for NEES, linking earthquake researchers across the U.S. with leading-edge computing resources and research facilities. The cyberinfrastructure allows earthquake researchers to use NEES' world-class facilities to conduct collaborative research on ways to minimize the risks of future earthquakes and tsunamis. (ENG/CMMI)

NSF-WIDE INVESTMENTS

BIOCOMPLEXITY IN THE ENVIRONMENT

The world is facing significant scientific and societal challenges, including the prospect of rapid environmental and climate change and the complicated question of long-term environmental security. The integrity of local, regional, and global ecosystems is inextricably linked to human well-being, and environmental and human health often intertwine. While exploration of complex environmental systems poses significant research challenges, it is a necessary 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. Thus, both scientific and practical needs for clear quantitative understanding of the world motivate continued focus on the investigation of complex environmental systems.

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 complex environmental systems in which the dynamic behavior of biota is linked to the physical and chemical processes of 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 behavior. Advanced computational and mathematical modeling strategies are intrinsic to this research. 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 molecular structures to genes to organisms to ecosystems to urban centers – interact with their environment.

Biocomplexity in the Environment Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biological Sciences	39.86	30.43	9.43	-21.00	-69.0%
Computer and Information Science and Engineering	8.00	3.00	-	-3.00	-100.0%
Engineering	6.00	5.94	4.00	-1.94	-32.7%
Geosciences	37.22	36.85	26.11	-10.74	-29.1%
Mathematical and Physical Sciences	3.83	3.36	1.00	-2.36	-70.2%
Social, Behavioral and Economic Sciences	2.00	2.00	1.08	-0.92	-46.0%
Office of International Science and Engineering	0.71	0.25	0.13	-0.12	-48.0%
Office of Polar Programs	1.55	1.53	0.83	-0.70	-45.8%
Total, Biocomplexity in the Environment	$99.17	$83.36	$42.58	-$40.78	-48.9%

Totals may not add due to rounding.

FY 2007 is the final year of this very successful priority area. In the words of external evaluators, "BE has fostered an important new area of multidisciplinary research addressing challenging environmental questions, including the explicit role of humans." This assessment is based on the impressive response from the scientific community. In addition to research accomplishments, BE has prompted realignments of academic departments, initiation of a new journal, special conferences and sessions, and professional society meetings. In order to continue to advance a 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, NSF will support interdisciplinary studies of this type within the structure of its regular programs. In FY 2007, specific programs that have demonstrated their importance and potential for innovation will be supported within the BE priority area. After FY 2007, this research portfolio will be referred to as Complexity in Environmental Systems (CES).

Long-term Goals: NSF will emphasize research and education on *Biocomplexity in the Environment*. This priority area is part of investments and accomplishments within NSF's FY 2007 environmental investment of over $850 million. 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, 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 such as 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	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request
$50.00	$54.88	$58.10	$70.12	$104.11	$99.17	$83.36	$42.58

FY 2007 Areas of Emphasis: In FY 2007, NSF plans to invest $42.58 million in the interdisciplinary Biocomplexity in the Environment activities described below. Three primary areas that stress the interactions of humans and biota with both the natural and manmade environments will be supported.

- **Carbon and Water in Earth Systems** – This research aims to increase fundamental understanding of the interrelation of physical, chemical, geological, hydrologic, atmospheric, and biological processes that comprise the Earth's natural systems. In particular, it will address interdisciplinary gaps in understanding the carbon and water cycles as they pertain to life, the global environment, and climate change. Critical feedbacks, coupling, and interactions of the carbon and water cycles will be emphasized. Examples of areas that will be investigated include the oceanic mesopelagic layer, continental margins, and wetlands. Included, too, is research on the complex processes, both abiotic and biotic, that effect variability in freshwater resources.

- **Dynamics of Coupled Natural and Human Systems** – This research involves quantitative interdisciplinary analyses of relevant human and natural system processes and the complex interactions among human systems and natural systems at diverse scales. Example areas of study include land use, the role of institutions in decision-making, and social valuation of biodiversity.

- **Materials Use: Science, Engineering and Society** – These studies are 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 complex environmental systems, as well as maximizing the efficient use of individual materials throughout their life cycles.

It is anticipated that these three areas will continue as independent programs in the future after the BE priority area ends in FY 2007. Carbon and Water in Earth Systems will be housed in the Geosciences Directorate, and Materials Use: Science, Engineering and Society will be housed in the Engineering Directorate. It is expected that Dynamics of Coupled Natural and Human Systems is expected to continue with support from several directorates.

These three areas will be complemented by multidisciplinary research and education activities that use a synthetic approach to understanding complex environmental systems. These include:

- Environmental Genomics – the integrated use of genomic and information technology methods to gain novel insights into environmental questions and problems.
- Sensor Development – development of innovative and robust sensors for use in specific challenging environmental applications.
- Education Activities – projects designed to integrate education and research on complex environmental systems and to promote workforce development, including increased participation of underrepresented minorities and the professional development of science teachers.

Recent Research Highlights

► **What Fisheries Management Teaches Us about Protecting Coral Reefs** With fisheries management moving more and more toward ecosystems-based approaches, instead of focusing on each fish species in isolation, a new piece of research funded under NSF's Biocomplexity in the Environment program has shown how subtle such an approach can be. It turns out that one major reason for the decline of Caribbean coral reefs is an excessive growth of seaweed. So it might seem that reefs would be healthier if they had more parrotfish and other such herbivores that could eat the seaweed. But that's not quite true, the researchers found. In "no-take" marine reserves where fishing is not allowed, the coral reefs begin to support more predator species such as grouper, and the predators, in turn, start to lower the population of parrotfishes. Yet the reef continues to thrive. The parrotfish that remain are both bigger, which helps them escape being eaten, and hungrier: they eat more than their smaller brethren, and so have a greater impact on the seaweed.

In short, this project helped demonstrate that at least one ecosystems-based management tool, no-take marine reserves, could be quite effective—for reasons that would be hard to guess in advance.

► **The Changing Landscape of East Africa** At a time when eastern Africa is undergoing extremely rapid changes in land-use patterns, from the massive migration of rural folk into cities to the steady spread of farming into savanna lands, an international team of researchers funded under NSF's Biocomplexity in the Environment program has carried out one of the first complete "close-the-loop" studies of the process. The goal of this research, conducted under the Climate-Land Interaction Project (CLIP), is to achieve a better understanding of how land-use decisions interact with climate change at regional and local scales—and how both circle back to influence future land-use decisions. For example, one of the most striking findings so far is that rapid urbanization can actually have a major effect on rural landscapes. This is partly because the urban market for food creates an incentive for higher-intensity agriculture, and partly because most of the energy used to cook food in east African cities comes from charcoal and wood harvested from natural woodlands and savannas. The resulting shifts in land use, in turn, will likely have a large impact on the regional climate.

New farms carved out of the savanna along the Kindaruma Dam in Machakos, Kenya. *Credit: Photo courtesy of Jennifer Olson*

Such basic issues are of critical importance to governments, industry, agriculturalists, and others throughout the world. CLIP also actively engages U.S. and Eastern African students in the conduct of interdisciplinary research.

CLIMATE CHANGE SCIENCE PROGRAM

Climate has a pervasive effect on the U.S. through its impact on the environment, natural resources, and the economy. To respond to the challenge of understanding climate and climate variability, the Climate Change Science Program (CCSP) was established in 2002 (http://www.climatescience.gov/). It is providing the Nation and the world with the science-based knowledge to predict change, manage risk, and take advantage of opportunities resulting from climate change and climate variability. Research conducted through CCSP builds on the scientific advances of the last few decades and deepens our understanding of how the interplay between natural factors and human activities affect the climate system. The CCSP engages thirteen U.S. agencies in a concerted interagency program of basic research, comprehensive observations, integrative modeling, and development of products for decision-makers. NSF provides support for the broad range of fundamental research activities that form a sound basis for other mission-oriented agencies in the CCSP and the Nation at large.

The Earth's climate is determined by highly complex interactions between and among the atmosphere, hydrosphere, cryosphere, geosphere, and biosphere. NSF programs address these components by investing in challenging research, creative people, and new research tools. As a key participating agency in the CCSP, NSF encourages interdisciplinary activities and focuses particularly on Earth system processes and the consequences of change. High priorities for the agency include data acquisition and information management activities necessary for global change research, the enhancement of models designed to improve our understanding of Earth system processes, the development of new, innovative Earth observing instruments and platforms, and the development of advanced analytic research methods. NSF also supports fundamental research on the general processes used by organizations to identify and evaluate policies for mitigation, adaptation, and other responses to varying environmental conditions. Through its investment, NSF contributes to CCSP by providing a comprehensive scientific foundation for many of the synthesis and analysis products identified in the CCSP Strategic Plan.

Climate Change Science Program Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biological Sciences	15.10	15.10	15.10	-	-
Engineering	1.00	1.00	1.00	-	-
Geosciences	150.35	149.35	157.72	8.37	5.6%
Mathematical and Physical Sciences	5.45	5.45	5.45	-	-
Social, Behavioral and Economic Sciences	15.48	15.48	15.48	-	-
Office of Polar Programs	10.50	10.50	10.50	-	-
Total, Climate Change Science Programs	$197.88	$196.88	$205.25	$8.37	4.3%

Totals may not add due to rounding.

FY 2007 Areas of Emphasis:

Atmospheric Composition – NSF programs in tropospheric and stratospheric chemistry will continue in FY 2007 to address the composition of the atmosphere and its relation to climate variability and change, and linkages between the atmosphere and the biosphere, land surface, oceans, and cryosphere. Studies of the transformation and transport of gaseous constituents and aerosols provide insights into the radiative and cloud nucleating properties of the atmosphere. Studies of the global distributions of greenhouse gases will provide input for future scenarios of radiative forcing.

Climate Variability and Change – As a major focus in FY 2007, NSF programs continue to emphasize climate variability and change across temporal scales. This research element supports observational campaigns and numerous analytical and modeling activities. Ocean science efforts will concentrate on changes in ocean structure, circulation, and interactions with the atmosphere to improve our current understanding of the processes and models that address future changes, particularly those that may happen abruptly. Major support will continue to permit the Community Climate System Model to improve model physics and parameterizations that will lead to more comprehensive models incorporating interactive chemistry and biogeochemical cycles. Studies of paleoclimatology will continue to be supported as a means to provide baseline data on natural climate variability from the past and from key climatic regions. These studies will improve our understanding of the natural variability of the climate system and in particular will enable reconstructions and evaluations of past environmental change as inputs for model validations.

The Global Water Cycle – NSF supports a broad-based effort to understand all aspects of the global water cycle. Relevant programs will continue to explore ways to optimally and effectively utilize the wide range of hydrologic data types – continuous and discrete time and space information from a variety of platforms – for research purposes. Information from process studies will be used to refine models through scaling and parameterizations of sub-grid processes, particularly the fluxes of water through the Earth system. New ultra-high resolution "cloud system resolving" models are being developed and refined to address the persistent problem of representing moist convection and cloud processes – two of the most challenging and uncertain components in climate change calculations. Planning and initiation of several prototype hydrologic observatories, both physical and virtual, are being carried out. Science and Technology Centers will continue to work with stakeholders responsible for water management and with educators to translate research advances into useful products, particularly exploring issues related to decision-making in the face of uncertainty as applied to the urbanizing and drought-prone Southwest.

Land-Use and Land-Cover Change – Several NSF programs continue to address key aspects of land-use and land-cover change through studies in ecological rates of change and related species diversity, Arctic systems, temporal variability, water and energy influences on vegetative systems, and diverse human influences on land use.

Global Carbon Cycle – FY 2007 funding supports a wide variety of carbon cycle research activities. Investigations will examine a range of topics in terrestrial and marine ecosystems and their relations to the carbon cycle. Research in terrestrial settings will explore, for example, carbon storage, delivery of carbon by rivers, carbon fluxes from high-latitude soils, carbon export from mountains, and submarine groundwater discharge. In the oceans, clathrate stability, the "biological pump", abiotic carbon cycling, and the upper ocean carbon budget will be addressed. Carbon cycle studies will integrate observational data into models to provide insights for understanding key aspects of the global carbon cycle and feedbacks on the climate system.

Ecosystems – Several NSF programs address terrestrial and marine ecosystems through observational, experimental, modeling, and laboratory studies. The Long Term Ecological Research (LTER) Program supports the collection of time-series data on key ecosystem processes and funds research on the drivers of ecosystem change in terrestrial and marine systems. The Global Ocean Ecosystem Dynamics program will continue to study the impact of global ocean changes on marine ecosystems through specific synthesis activities focused on the North Atlantic and the North Pacific. One new theme will focus on understanding the impact of increasing carbon dioxide levels on the calcification rates, productivity and symbiotic relationships of hermatypic corals.

Human Contributions and Responses – NSF supports basic research on the processes through which people (individually, in groups, or through organizations) interact with natural environmental systems. FY 2007 funding supports projects that focus on decision-making under uncertainty associated with climate change. These projects are expected to produce new knowledge and tools that should facilitate improved decision-making by various stakeholder groups trying to deal with uncertainties associated with future climate variability and change.

CYBERINFRASTRUCTURE

Science and engineering research and education have become increasingly compute- and data-intensive, as a result of the proliferation of digital tools and pervasive networks through which scientific resources, methodologies, data and outcomes are collected, generated, shared, or analyzed. The comprehensive infrastructure needed to capitalize on dramatic advances in information technology has been termed cyberinfrastructure. Cyberinfrastructure integrates hardware for computing, data and networks, digitally-enabled sensors, observatories, and experimental facilities, using an interoperable suite of software and services and tools. Investments in interdisciplinary teams and cyberinfrastructure professionals with expertise in algorithm and software development, system operations, and applications development are also essential to exploit the full power of cyberinfrastructure to create, disseminate, and preserve scientific data, information, and knowledge. The enormous growth in the availability and utility of cyberinfrastructure capabilities, both technology- and human-based, is increasing scholarly research productivity, accelerating the transformation of research outcomes into products and services that drive economic growth, and enhancing the effectiveness of learning across the spectrum of human endeavor.

Together with the growing availability and capability of cyberinfrastructure tools, this emerging cyberinfrastructure is revealing new knowledge and fundamental insights. For example, analyses of DNA sequence data are providing remarkable insights into the origins of man, are revolutionizing our understanding of the major kingdoms of life, and are revealing stunning and previously unknown complexity in microbial communities. Sky surveys are changing our understanding of the earliest conditions of the universe and providing comprehensive views of phenomena ranging from black holes to supernovae. Researchers are monitoring socio-economic dynamics over space and time to advance our understanding of individual and group behavior and their relationship to social, economic, and political structures. Using combinatorial methods, scientists and engineers are generating libraries of new materials and compounds for health and engineering, and environmental scientists and engineers are acquiring and analyzing streaming data from massive sensor networks to understand the dynamics of complex ecosystems. In the future, U.S. leadership in science and engineering will increasingly depend upon our ability to tap into this growing reservoir of digitally-encoded scientific knowledge.

Cyberinfrastructure Funding

(Dollars in Millions)

	FY 2005 Actuals	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biological Sciences	$77.00	$84.00	$90.50	$6.50	7.7%
Computer and Information Science and Engineering	45.32	63.00	68.00	5.00	7.9%
Engineering	52.00	52.00	54.00	2.00	3.8%
Geosciences	71.35	71.35	75.00	3.65	5.1%
Mathematical and Physical Sciences	56.52	59.30	63.56	4.26	7.2%
Social, Behavioral and Economic Sciences	20.39	20.54	20.54	-	-
Office of Cyberinfrastructure	123.28	127.12	182.42	55.30	43.5%
Office of International Science and Engineering	0.22	1.00	1.05	0.05	5.0%
Office of Polar Programs	25.38	26.24	26.24	-	-
Subtotal, Research and Related Activities	471.47	504.55	581.31	76.76	15.2%
Education and Human Resources	20.27	15.02	15.52	0.50	3.3%
Total, Cyberinfrastructure Funding	$491.74	$519.57	$596.83	$77.26	14.9%

Increases in the capability and affordability of cyberinfrastructure are permitting the creation of powerful research and education tools and services that enable discovery, learning, and innovation across a range of science and engineering disciplines:

- Environmental scientists and engineers are drawing upon cyberinfrastructure to investigate the complexity of our environment, from the molecular to the planetary scale. This multidisciplinary work requires the collection and analysis of large volumes of data, it requires experiments with computer models that in many cases depend upon the world's most advanced supercomputers, and it relies upon the collaboration of scientists and engineers from a wide range of disciplines.
- Earthquake engineers are accessing shake tables, reaction wall facilities, geotechnical centrifuges, tsunami wave tanks, and mobile field equipment that are integrated through a common cyberinfrastructure framework, allowing them to perform tele-observation and tele-operation of experiments; to publish to and make use of curated data repositories; to access computational resources and open-source analytical tools; and to use collaborative tools for experiment planning, execution, analysis, and publication.
- Plant biologists are using cyberinfrastructure tools developed to extract implicit genome information to reveal the structure and function of plant genes at levels from the molecular to the organismal. The new knowledge and insights gained from plant genomics will lead to new discoveries and conceptual advances in our understanding of the biology of plants, as well as to the broader impact of this new knowledge in applications relating to agriculture, natural resources, the environment, health, and plant-based industries.
- Computer scientists and engineers are conducting research on next-generation systems architectures that will enable future generations of cyberinfrastructure. Research advances will enable the development of cyberinfrastructure systems that, for example, monitor and collect information on such diverse subjects as plankton colonies, endangered species, soil and air contaminants, medical patients, and buildings, bridges, and other man-made structures. Across a wide range of applications, cyberinfrastructure systems promise to reveal previously unobservable scientific phenomena.

All programmatic Directorates and Offices support cyberinfrastructure. The Office of Cyberinfrastructure makes investments common to a broad range of science and engineering fields, promoting economies of scale and scope, and facilitating interoperability. Other programmatic Directorates and Offices make cyberinfrastructure investments necessary to meet their missions.

FY 2007 Areas of Emphasis:

- Support will be provided for the Protein Data Bank (PDB), the international repository and primary source for information about the structure of biological macromolecules, a key research resource and central component to our understanding of living systems.
- As recommended in the 2004 report of the High-End Computing Revitalization Task Force, funding for research on high performance computing architectures will leverage interagency coordination and collaboration activities.
- Acquisition of a leadership-class high performance computing system will begin in FY 2007, to support petascale simulations essential to progress in many science and engineering fields. As recommended by the High End Computing Revitalization Task Force, this acquisition will be conducted in close collaboration with other agencies with a stake in high performance computing.
- Support will be provided for the Arctic Systems Sciences (ARCSS) Data Coordination Center that serves as a central point for deposition of data deriving from ARCSS-funded research. All projects

that produce data are expected to deposit their data at the Center. In cases where data is more appropriately deposited elsewhere, the Center keeps track of metadata. The Center ensures that data sets are published on-line and that they are broadly accessible to the community.

- An agency-wide programmatic activity, called CI-TEAM, will prepare thousands of scientists and engineers at the undergraduate, graduate, postdoctoral and faculty levels to use cyberinfrastructure in their research and education activities.
- Support for the National Radio Astronomy Observatory and the National Optical Astronomy Observatory will include enhanced efforts to make available long-term data archives for astronomical research and education.
- Substantial investments will be made in major social and behavioral science data collections, and will address issues such as confidentiality protections and means for securing worldwide, user-friendly access.
- Continuing investments will be made in the National STEM Digital Library (NSDL) to support a national resource of high-quality Internet-based STEM educational content and services to support learners at all levels.
- Projects that provide the nation's multidisciplinary computational science and engineering community with access to high performance computing resources and services will be supported, with an increasing investment in software infrastructure. High performance resources permit researchers to perform: lattice gauge calculations of properties of elementary particles; astrophysical simulations such as in the study of supernovae, accretion and jets, or galaxy dynamics; calculations of astrophysical processes using, for example, strong-field general relativity to compute gravitational wave signatures of colliding black holes; and first-principles calculations of the properties and dynamics of atomic, molecular, and nuclear systems using QED and the nucleon-nucleon force.
- Development of next-generation data management systems and tools will improve support of domain specific data types, such as sequences, pathways, and time series data.

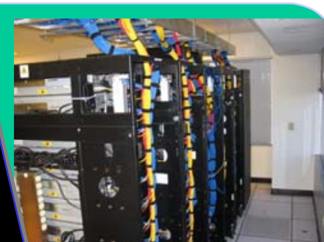
Over time, NSF investments will contribute to the development of a powerful, stable, persistent, and widely accessible cyberinfrastructure to enable the work of science and engineering researchers and educators across the nation and around the world.

Recent Research Highlights

► **Collaborative Research: Cyber Defense Technology Experimental Research Network (DETER):** Cybercrimes, including hacking, denial of service attacks, worms, viruses and other malicious attempts to corrupt or take control of networked computers, are a major threat to our nation's security. Yet it has been difficult to fully evaluate the effects of such attacks, or to test solutions to thwart these crimes, because researchers have not had access to suitable test environment.

Goal: to create, maintain, and support a collaborative and vendor-neutral experimental environment for cyber-security research. It is intended to provide a center for interchange and collaboration among security researchers and testbed builders.

DETER research community: a group of academic, industry, and government researchers working to improve defenses against malicious attacks on our networking infrastructure, especially critical infrastructure.



DETER testbed: a shared testbed infrastructure that is specifically designed for medium-scale (e.g., 100 node) repeatable experiments, and especially for experiments that may involve "risky" code.

To address this challenge, NSF funds a vendor-neutral testbed called DETER: a collaborative project of the University of California at Berkeley, University of California at Davis, and University of Southern California. DETER provides academic, government and industrial scientists a safe environment to contain, model and analyze malicious attacks -- especially those that might result in catastrophic damage to public networks supporting critical infrastructure. In the isolated and controlled DETER environment, researchers can unleash “risky code” (such as worms, viruses, denial of service attacks and other targeted strikes), and then aggressively test counter-responses without fear of infecting public networks.

HUMAN AND SOCIAL DYNAMICS

The Human and Social Dynamics (HSD) priority area supports multidisciplinary approaches to understanding change in human and social systems and their environments. HSD aims at scientific breakthroughs that will aid people, policy makers, and organizations as they seek to understand, manage, and adapt to change.

Almost every major challenge this country faces, ranging from climate change to terrorism to the need for an educated workforce, has at its core important human and social dynamics. New technologies, such as high-speed computers and functional magnetic resonance imaging machines, and new methods for collecting and analyzing data have dramatically increased the contributions that the social, behavioral, and economic sciences can make to understanding the processes that shape human and social action. HSD builds upon unprecedented opportunities for fruitful synergies across the social and behavioral sciences and with other fields of sciences and engineering. Together the NSF directorates can push the frontiers of knowledge, where discovery and innovation are likely.

The title *Human and Social Dynamics* captures the priority area's crucial defining elements. HSD focuses on human beings, with special attention to individual behavior and cognition. HSD focuses on groups, organizations, societies, and institutions, as they influence and are affected by changes in social and physical environments. HSD focuses on understanding systems that are constantly changing and being changed. Interactions and feedbacks in these dynamic systems are not adequately captured by standard linear models and transcend traditional disciplinary boundaries.

Human and Social Dynamics Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biological Sciences	$0.50	$0.50	$0.50	-	-
Computer and Information Science and Engineering	3.00	3.00	5.00	2.00	66.7%
Engineering	2.00	2.00	2.00	-	-
Geosciences	1.35	1.35	1.35	-	-
Mathematical and Physical Sciences	0.50	0.50	0.50	-	-
Social, Behavioral and Economic Sciences	30.90	31.40	31.40	-	-
Office of International Science and Engineering	0.06	0.50	0.50	-	-
Office of Polar Programs	-	0.20	0.20	-	-
Total, Human and Social Dynamics	$38.31	$39.45	$41.45	$2.00	5.1%

Totals may not add due to rounding.

This focus on the dynamic aspects of human and social behavior promises to bring about important advances in what is known about human action and development as well as organizational, cultural, societal, and technological adaptation and change. The HSD priority area requires research by interdisciplinary teams, and encourages international collaborations and proposals that link researchers from SBE science disciplines with those from other science and engineering disciplines.

This priority area began in FY 2003 within the Social, Behavioral, and Economic Sciences Directorate (SBE). In FY 2004, HSD expanded to reach across all NSF science and engineering disciplines. In response to the large number of meritorious FY 2004 submissions, NSF increased the funds available for support of HSD awards in FY 2005 and issued a solicitation in FY 2005 seeking proposals to be funded with FY 2005 and FY 2006 appropriations. This decision allowed a timely response to the earthquake/tsunami disasters in the Pacific in December 2004. The 2005 solicitation included a notice that HSD would accept proposals for Small Grants for Exploratory Research (SGER), resulting in the receipt of 33 SGER proposals and yielding six awards for multidisciplinary, time-sensitive research. Funded projects include studies of the roles of natural and social infrastructures in increasing or diminishing vulnerability to disasters, cultural issues in handling human remains, and responses to natural warning signs. In the FY 2005 competition, 448 exploratory research and research team proposals were considered. All proposals included three or more senior personnel from at least two different fields. HSD is supporting about 26 percent of these submissions, totaling nearly 120 awards. FY 2006 brought Hurricane Katrina, and HSD again issued a SGER notice that resulted in 190 proposals and 33 awards. These new projects are fielding interdisciplinary teams to examine how people and organizations responded to the disaster and how they are proceeding to rebuild their lives and their cities.

Long-term Goals: The Foundation is emphasizing interdisciplinary research that will:

- Improve decision making through research that focuses on individual, group, and societal attempts to identify, characterize, evaluate, and manage situations that call for choices and decisions and involve changing perceptions of uncertainty and risk.

- Explore the causes and consequences of large-scale social transformations, including globalization, democratization, scientific and technological innovation, and the changing development of human societies and their institutions and subsystems over time.

- Advance understanding of changes in human behavior and performance, at the individual, social, and population levels, by exploring the neurological, sensory-motor, psychological, informational, and social and organizational systems that produce or impede coordinated efforts within and between individuals.

- Develop new methods, tools, and enhancements in cyber and other scientific infrastructure needed to promote path-breaking disciplinary and interdisciplinary contributions in the natural and physical sciences, as well as in the social and behavioral sciences and engineering.

- Encourage researchers to "think big" about integrated research questions, through grants of a size and duration that allow substantial coordination across researchers, disciplines, and project areas.

- Significantly advance data resources and stimulate new problem definitions and framings within which novel research techniques can be tested and put into practice.

Long-term Funding for Human and Social Dynamics

(Dollars in Millions)

FY 2003 Actual	FY 2004 Actual	FY 2005 Actual	FY 2006 Plan	FY 2007 Request	FY 2008 Estimate	FY 2009 Estimate
$4.46	$30.07	$38.31	$39.45	$41.45	$42.00	$40.00

Estimates for 2008 and beyond do not reflect policy decisions and are for planning purposes only.

FY 2007 Areas of Emphasis: In FY 2007, NSF plans to invest $41.45 million in interdisciplinary research on *Human and Social Dynamics*. Team efforts and international collaborations will be encouraged and a mixed portfolio will be funded, including major research projects and exploratory projects aimed at research community development, education, and improvement of tools and infrastructure. Change remains the focus of the FY 2006 – FY 2007 competition, which will continue to support research at various scales, including individual, group, and organizational behavior as structured phenomena that develop over time. This focus continues with the substantive themes of prior HSD competitions: dynamics of human behavior; decision making, risk, and uncertainty; and agents of change. As part of a continuing five-year investment in conjunction with the Administration's Climate Change Science Program, $5.0 million will be devoted to decision making under uncertainty as it relates to climate change.

- **Dynamics of Human Behavior –** A wide range of intertwined sciences contributes to this research, which explores social, cognitive, linguistic, developmental, organizational, cultural, and biological processes that affect behavior. Relevant research includes work on the development of human communication, the cognitive requisites for effective human-machine interfaces, and the resilience of individuals, groups, and organizations to unexpected, exogenous shocks. Such research can model ways to improve human interaction in settings ranging from research laboratories to neighborhoods to school classrooms to nursing homes.

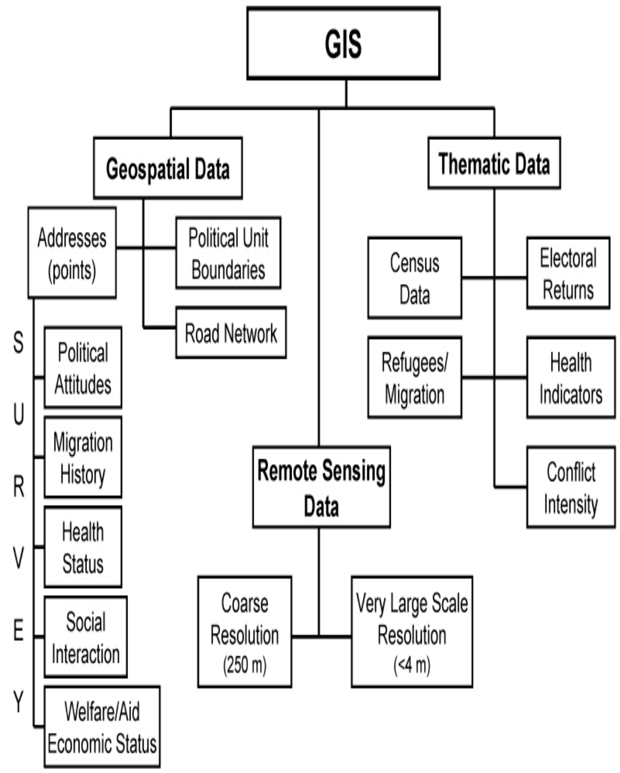
- **Decision Making, Risk, and Uncertainty –** Research on decision making, risk, and uncertainty enables a better understanding of such matters as the cognitive neuroscience of risk assessment, hypothesis construction and testing in the face of biases, distributed versus centralized decision making, the construction of effective decision support systems, and risks posed by extreme events, such as natural disasters and terrorist attacks. Development of test beds can examine vulnerability and resilience, and extrapolate and predict future losses and loss mitigation possibilities.

- **Agents of Change –** HSD research examines the dynamics and consequences of large-scale social transformations, such as the interactions of science and technology with globalization and democratization, and more focused systemic changes, such as the interactions of political, economic, environmental, and educational systems with agents of change. One goal is to gain a better understanding of how social systems and their constituent parts react to different drivers of change, ranging from ideology to the internet.

In these focal areas, HSD also supports advances in the infrastructure, tools, education, and resources needed to achieve breakthroughs. These include cybertools such as sensors and modes of connectivity; advances in modeling, including agent-based modeling, network analysis, and non-linear dynamics; improved methods to organize and analyze complex datasets; and projects to improve such infrastructure as instrumentation, virtual collaborations and laboratory networks, and data resources. Developments in spatial social science, for instance, use geo-spatial tools to integrate locational information with other social data to shed light on effects of neighborhood on crime, diffusion of innovations, and growth of virtual, regional, and global networks. Educational efforts aim at promoting interdisciplinary approaches, instructing user communities in the use of promising tools and models, and communicating the fruits of the HSD priority area to students at all levels.

Recent Research Highlight:

► **The Dynamics of Civil War Outcomes: Bosnia and the North Caucasus:** Scientists from five U.S. universities, with research partners in Russia and Bosnia, are collaborating to help determine the prospects for peaceful relations between war-torn regions. Using a combination of individual and aggregate data from opinion surveys, census counts, government agencies, and remote sensing., the project builds a Geographic Information System for each study region that integrates three types of data (satellite imagery, census and other aggregate data, survey data) at multiple scales.



This research deepens the empirical analysis of the underlying factors of possible future conflicts, gauging the prospects for peaceful relations between nationalities. Data and findings will help to answer key questions about the nature of community conditions in former war zones, as local, national and international agencies try to cope with disruptions to peoples, economies, and environments over the past 15 years. (Managed by SBE with cross-directorate support).

INTERNATIONAL POLAR YEAR

The International Polar Year (IPY) in 2007-2008 will mark the 50th anniversary of the International Geophysical Year (IGY) 1957-58, in which unparalleled exploration of Earth and space led to discoveries in many fields of science that have forever changed the way we view the polar regions and their global significance. Countries around the world are now actively planning their IPY activities, and the International Council for Science (ICSU) and the World Meteorological Organization (WMO) are working to provide project integration where appropriate.

The U.S. National Academies of Science (NAS) developed broad goals and objectives for U.S. IPY activities and the White House Office of Science and Technology Policy tasked NSF with serving as the lead federal agency for implementing IPY 2007-2008. A further source of information on U.S. IPY activities can be found at www.US-IPY.org. The U.S. vision developed by and articulated in the NAS/National Research Council (NRC) document, *A Vision for the International Polar Year 2007-2008*, urges the U.S. scientific community and agencies to participate as leaders in IPY and to address five broad scientific challenges:

- Assessing large-scale environmental change in the polar regions, with questions looking at both the physical and human dimensions of change and its impacts;
- Conducting scientific exploration of "new" frontiers, whether these are once inaccessible places such as the seafloor, or areas of inquiry that are now open because of advances in technology, such as how genomics tools now allow investigation of previously unanswerable questions about biological adaptation;
- Observing the polar regions in depth, with adequate coverage of the vast and challenging landscape, to provide a description of current conditions and allow for better future understanding of variability and change;
- Understanding human-environmental dynamics in a region where the connections are intimate and where the impacts of change are clear; and
- Creating new connections between science and the public, building on the inherently intriguing character of these regions.

NSF's approach to IPY addresses the challenges posed by the Academies' vision publication and is consistent with the Administration's guidance on federal R&D investments (i.e., that investments sustain agency missions through stewardship of user facilities, enhance the Nation's ability to understand and respond to global environmental issues, and strengthen international partnerships that foster advancement of scientific frontiers) while contributing to and stimulating an array of learning opportunities for citizens of all ages in linking our activities to those in other countries.

IPY will provide a framework and impetus to undertake research projects that normally could not be achieved by any single nation. It allows us to think beyond traditional boundaries – whether national borders or disciplinary constraints – toward a new level of integrated cooperative science linked to education and outreach efforts. More than 25 nations have formally declared their intent to participate and many more are sure to follow. NSF will use IPY to strengthen existing international relationships and forge new connections to address the broad and interlinked research challenges faced by all participating nations.

Once underway, IPY will involve people of all ages, from all walks of life, and from diverse backgrounds — from teachers to students and artists to scientists. It is NSF's responsibility to reach out and build awareness of the scientific discoveries that will evolve from this international, collaborative research venture. In keeping with this vision, NSF has outlined its own set of goals for the conduct of internationally coordinated research and education that will be visible to the public through extensive outreach efforts.

FY 2007 Areas of Emphasis:

Proposed IPY investments and activities support focuses on three research areas ─ **Study of Environmental ARctic CHange (SEARCH); Polar Ice Sheet Dynamics and Stability; and Life in the Cold and Dark** ─ that will advance fundamental scientific discovery to improve future quality of life and enhance our ability to understand and respond to global environmental issues. Further, the structure of IPY ─ requiring international collaborations ─ specifically responds to the goal to strengthen international partnerships that foster advancement of scientific frontiers and accelerate the progress of science across borders. Additionally, the proposed infrastructure investments to support IPY, such as investing in NOAA's Barrow Global Change Climate Research Facility and Antarctic surface traverse vehicles, are critical to NSF's missions and to support the missions of other agencies through stewardship of user facilities. Plans for IPY are multi-agency and interagency, and the three broad research areas mentioned above tie directly to two Administration priorities, Understanding Complex Biological Systems and Energy and Environment.

International Polar Year Funding

NSF funding for IPY activities will consist of commitments from a number of ongoing NSF programs throughout the agency that will build on the Office of Polar Programs (OPP) core investments designed to facilitate world leadership in this worldwide activity. NSF's IPY FY 2007 request totals $61.57 million. It is estimated similar amounts will be requested in FY 2008.

IPY investments for FY 2007 address the challenges in research, education, and outreach posed by the National Academies. It will also provide funding for polar logistics and infrastructure that will make IPY research possible. The investments will be administered by OPP in collaboration with other NSF offices and directorates and will focus initially on advancing the frontiers of knowledge in the three previously mentioned broad areas: 1) **SEARCH**, 2) **Polar Ice Sheet Dynamics and Stability**; and 3) **Life in the Cold and Dark**.

NSF directorates and offices will also support a broad range of smaller innovative projects from ongoing programs that respond to the NAS/NRC guidelines.

International Polar Year Funding

(Dollars in Millions)

	FY 2007 Request
Biological Sciences (BIO)	$2.00
Geosciences (GEO)	5.00
Office of International Science and Engineering (OISE)	0.30
Office of Polar Programs (OPP)	47.27
Social, Behavioral and Economic Sciences (SBE)	5.00
Subtotal, Research and Related Activities (R&RA)	59.57
Education and Human Resources (EHR)	2.00
Total, IPY Funding	**$61.57**

BIO will continue support for environmental genomics, including research in support of IPY activities related to **Life in the Cold and Dark.** A special focus will be the evolutionary ecology of infectious diseases with relevance to the effects of climate change in polar environments.

GEO will focus on climate modeling that couples polar ocean currents, climate, and sea ice extent to phenomena observed or predicted in mid-latitudes. Research activities associated with the Integrated Ocean Drilling Program are planned in the Arctic during FY 2007. Both Arctic and Antarctic observations of the polar upper atmosphere will be emphasized in order to better understand space weather, especially those using the new Advanced Modular Incoherent Scatter Radar in Alaska and at Resolute Bay, Canada.

OISE will partner with other NSF research directorates and offices and with foreign research organizations to catalyze international collaborations on polar research in support of IPY.

OPP will support a special competition for IPY as well as a broad range of smaller innovative projects that are responsive to the ICSU and NAS/NRC guidelines. In particular OPP will: 1) fund a significant component of the Arctic Observing Network, leveraging observing system investments made by international partners such as the European Union; 2) provide funding to allow key observations in lesser-known sectors of the West Antarctic Ice Sheet, and thus allow incorporation of these data into developing mathematical models of ice sheet dynamics; 3) provide funds for genomics in polar biology, to increase work to exploit genetic and molecular biology approaches toward understanding how organisms and ecosystems have adapted to the extreme conditions of the Antarctic; and 4) provide essential logistics and infrastructure improvements needed to implement activities planned for IPY.

SBE plans to support interdisciplinary research on human adaptation and change within polar environments that focuses on human/environment interactions from a range of perspectives, including physical anthropology and cognitive neuroscience, sociology and geo-political relations, and economics, as well as science and technology studies. These areas are applicable to **SEARCH** and **Life in the Cold and Dark.**

EHR will support formal science education experiences for K-12 teachers and undergraduate and graduate students, informal science education for the broader public, and coordination and communication for IPY education projects.

In all these activities NSF will collect and maintain legacy information using cutting-edge data management methods and provide shared access to the data products resulting from IPY activities. Each will be linked to NSF's education and outreach IPY goals and will be implemented with international collaborators. A concerted effort will also be made to:

- Engage the public in polar discovery through informal science education projects such as museum exhibits, large format films and television and radio documentaries. These will leverage the inherent appeal of the polar regions to inspire diverse audiences of all ages and to educate them about polar scientific research and the relevance of the polar regions to the earth system; and

- Attract and develop the next generation of scientists and engineers through hands-on field experiences in polar research for K-12 educators and graduate and undergraduate students as members of polar science teams, and prepare and inspire teachers to bring polar research to their classrooms and stimulate the interest of the next generation of scientists in international, collaborative research about the polar regions.

Recent Research Highlights

► **Penguins change … and stay the same:** When it is time to breed each year, a penguin typically returns to the same site where it was born. So it is logical to suppose that each separate colony would eventually develop its own distinctive genetic makeup.

But new studies using fossil DNA samples recovered from breeding sites show exactly the opposite. When NSF-supported researchers and their New Zealand colleagues compared the genes of present penguins to those from 6000 years ago, they found that the population as a whole has evolved. Yet they found no genetic differences between sites, even when the colonies were separated by thousands of kilometers.

Adelie penguin with chicks. *Photo credit: Emily Stone, the Antarctic Sun.*

Why? Recent events offer clues. Grounding of a large iceberg changed the geography of the ice, lengthening some foraging trips and blocking access to some colonies. Instead of returning to their natal sites, penguins migrated to other rookeries to mate and nest, thereby promoting genetic mixing. Such changes in ice conditions are not unusual, and may represent a longstanding evolutionary force.

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 microscale, nanoscale, 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 resources devoted to three key areas – fundamental mathematical and statistical research, interdisciplinary collaboration between the mathematical sciences and other disciplines, and mathematics education – have not kept pace with the needs, thus limiting the Nation's scientific, technical, and commercial enterprises. To strengthen the mathematical foundations of science and society, NSF has supported the Mathematical Sciences Priority Area since FY 2002. This investment focuses 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 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biological Sciences	2.21	2.21	1.11	-1.10	-49.8%
Computer and Information Science and Engineering	2.29	2.29	1.15	-1.14	-49.8%
Engineering	2.91	2.88	1.46	-1.42	-49.3%
Geosciences	7.07	7.00	3.53	-3.47	-49.6%
Mathematical and Physical Sciences	70.21	69.69	69.26	-0.43	-0.6%
Social, Behavioral and Economic Sciences	1.50	1.50	0.75	-0.75	-50.0%
Office of International Science and Engineering	0.32	-	-	-	N/A
Office of Polar Programs	0.20	0.20	0.10	-0.10	-50.0%
Subtotal, Research and Related Activities	86.71	85.77	77.36	-8.41	-9.8%
Education and Human Resources	2.85	2.20	1.09	-1.11	-50.5%
Total, Mathematical Sciences	$89.56	$87.97	$78.45	-$9.52	-10.8%

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 focused 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 long-term transformation in the way mathematics, science, and education interact. The long-term goals of the investments in the priority area that were articulated during its initial stages and continue as important goals are to:

- Foster significant advances in fundamental mathematics and statistics together with important benefits for the mathematical and other sciences and engineering;
- Foster interdisciplinary research partnerships that integrate the mathematical sciences with other science and engineering disciplines and recognize mathematicians and statisticians as full partners;
- Integrate the most appropriate, state-of-the-art, statistical principles and mathematical tools and concepts into all NSF sponsored research;
- 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 Mathematical Sciences
(Dollars in Millions)

FY 2002 Actual	FY 2003 Actual	FY 2004 Actual	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request
$30.00	$60.42	$91.56	$89.56	$87.97	$78.45

FY 2007 Areas of Emphasis: NSF plans to invest $78.45 million in the Mathematical Sciences activities described below, while starting to mainstream interdisciplinary research partnerships. FY 2007 is the last year of funding of the Mathematical Sciences Priority Area. In future years, these activities will be part of ongoing programs in the participating areas. There is strong commitment to continuing partnerships.

- **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 for increased support for collaborative research in which teams containing both mathematical scientists and researchers from other science and engineering disciplines work together: (a) to develop new mathematical approaches to concrete scientific or engineering problems for which adequate mathematical tools do not yet exist as well as (b) to apply these sophisticated techniques to significant problems in science and engineering. Such interdisciplinary collaborations will also nurture a new breed of researchers, broadly trained in both mathematics and science or engineering disciplines, 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, complex data streams. These challenges arise in such diverse arenas as: large genetic databases; the explosion of data gathered from earth monitoring systems (satellite observation systems, seismic networks, and global observation systems); 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 phenomena such as market behavior.

- **Modeling complex nonlinear systems** – Advances in mathematics are necessary for a fundamental understanding of the mechanisms underlying interacting complex systems and systems far from equilibrium. They are 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 engineered systems.

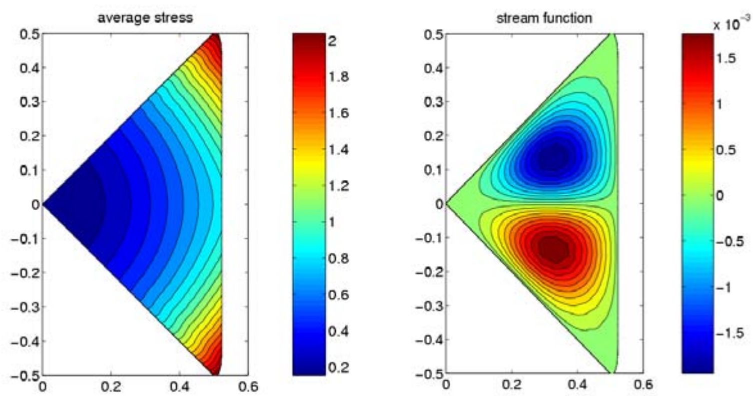
To enhance research in these areas of science and engineering, which depend on cross-cutting themes in the mathematical sciences, NSF will support opportunities encompassing interdisciplinary research groups, interdisciplinary centers, interdisciplinary cross-training programs, and partnership activities with other federal agencies. Training activities will cover interdisciplinary professional development at many levels and those that link highly innovative training activities with research.

- **Advancing Mathematical Sciences Education –** This effort will support innovative educational activities, centered on the research priorities highlighted above. Activities that foster closer connections between research and education 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, and for mentoring at key transition points in the careers of mathematical scientists. An area of focus that will continue in FY 2007 is to enhance undergraduate research experiences at the interface between the mathematical and biological sciences.

Recent Research Highlights

► **Computational Methods for Bulk Solid Handling Problems:** The handling of granular materials such as ores, building materials, chemical and pharmaceutical powders poses serious industrial problems. Silos routinely malfunction or even collapse. Some of those problems can be traced to the use of oversimplified models from the 1950s. NCSU Professor Pierre Gremaud in collaboration with Professor John Matthews (U. of Tennessee, Chattanooga) has recently made significant progress in the calculation of slow granular flows in industrial hoppers. Their approach allows the computational study of realistic industrial cases. This work is done in consultation with engineers at Jenike & Johanson, Inc. Once coupled with existing shell mechanics codes, those results will lead to the first comprehensive predictive tool for this type of phenomena and ultimately to more stable silos that are far less likely to collapse or malfunction. This research is representative of the type of contribution that mathematics can make for very real problems and the potential for positive economic impact.

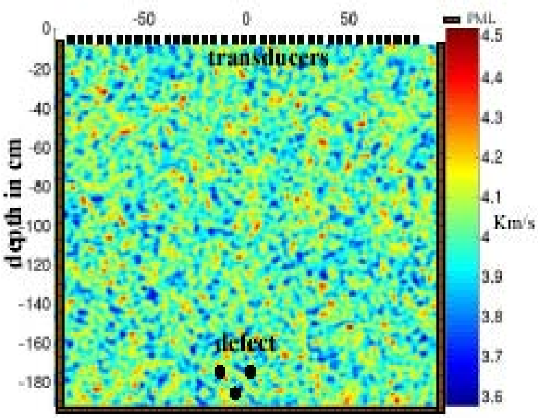
Collapse of Silo



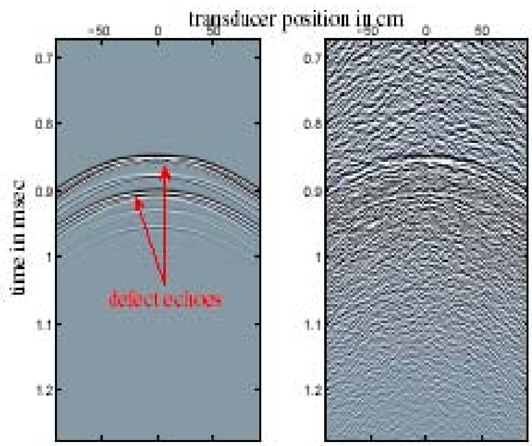
Calculations of the flow in a conical hopper with square cross section. Secondary circulation is observed. Only a quarter of the cross section is shown.

Credits: P. Gremaud, North Carolina University, J. Matthews, University of Tennessee, Chattanooga

► **Robust Imaging Algorithms for Nondestructive Testing of Materials:** Accurately inferring the internal structure of a body is a great challenge in all imaging applications, such as medical imaging, remote sensing, nondestructive testing of materials, object detection, and monitoring of underground flows, etc., because of the inherent inhomogeneity of the media. A group of mathematicians consisting of Professor Liliana Borcea of Rice University, Professor George Papanicolaou of Stanford University and Professor Chrysoula Tsogka of the University of Chicago, has been working to advance the mathematical techniques for imaging. Through collaborations with engineers and physicists, including A. Paulraj and J. Claerbout of Stanford University and W. Scott of the Georgia Institute of Technology, they made significant progress in developing a statistically stable imaging algorithm and applied it to nondestructive detection of defects in aging concrete. Their method involves the use of an array of transducers that sends ultrasonic waves and records that scattered echoes at the surface of the concrete structure and an Adaptive Interferometric Imaging algorithm that exploits the coherence in the data by calculating cross-correlations of the recorded echoes at the array over carefully chosen space-time windows. This approach is statistically stable in that it is insensitive to changes of the detailed structure of the material and gives a reliable identification of the defects.

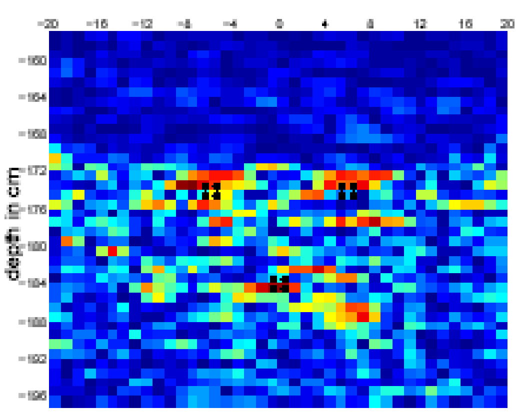


A schematic of sensing scenario

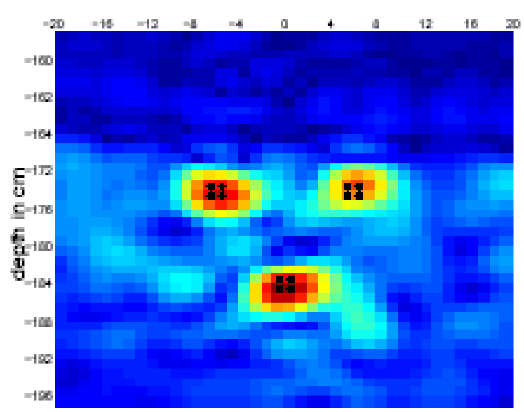


Resulting image assuming homogeneous medium

Resulting image in realistic inhomogeneous medium



Detection using conventional imaging algorithms



Detection using Adaptive Interferometric Imaging

Credit: Liliana Borcea, Rice University; George Papanicolaou, Stanford University; Chrysoula Tsogka, University of Chicago

NATIONAL NANOTECHNOLOGY INITIATIVE

Nanoscale science and engineering (NS&E) is NSF's major contribution to the multiagency National Nanotechnology Initiative (NNI). NS&E at NSF encompasses the systematic understanding, organization, manipulation, and control of matter at the atomic, molecular and supramolecular levels. Novel materials, devices, and systems – with their building blocks on the scale of nanometers – open up new directions in science, engineering, and technology with potentially profound implications for society. 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.

National Nanotechnology Initiative Funding
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biological Sciences	46.78	49.00	52.55	3.55	7.2%
Computer and Information Science and Engineering	7.78	12.00	12.87	0.87	7.2%
Engineering	123.77	127.77	137.02	9.25	7.2%
Geosciences	7.94	9.00	9.65	0.65	7.2%
Mathematical and Physical Sciences	143.27	141.54	156.42	14.88	10.5%
Social, Behavioral and Economic Sciences	1.57	1.56	1.67	0.11	7.1%
Office of International Science and Engineering	0.72	-	-	-	N/A
Subtotal, Research and Related Activities	331.83	340.87	370.18	29.31	8.6%
Education and Human Resources	3.16	2.90	3.00	0.10	3.4%
Total, National Nanotechnology Initiative	$334.99	$343.77	$373.18	$29.41	8.6%

Totals may not add due to rounding.

FY 2007 NNI Funding. NSF's contributes to the goals and seven program-component areas (PCAs) outlined in the NNI Strategic Plan (www.nano.gov). The modes of support include single investigator, multidisciplinary team, center, and network awards. The Nanoscale Interdisciplinary Research Teams (NIRT) awards encourage team approaches to address research and education themes where a synergistic blend of expertise is needed to make significant contributions. Within the total investment for NNI, $65.0 million will be allocated to 50 new awards on Nanoscale Interdisciplinary Research Teams or other NIRT-like activities.

FY 2007 Areas of Emphasis:

Fundamental nanoscale phenomena and processes. The FY 2007 Request includes $131.84 million for fundamental research and education, with special emphasis on:

- *Novel phenomena, quantum control, and basic engineering processes* – to discover and understand phenomena and design processes specific at the nanoscale, including new phenomena in materials, mechanics, chemistry, biology, electronics, and optics. Potential applications include quantum computing and new devices and processes for advanced communications and information technologies.
- *Biosystems at the nanoscale* – 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.

- *Converging science and engineering at the nanoscale* – 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 theme includes investments in (a) nano-biology interface and improving human performance, and (b) nano-information interface research.
- *Multi-scale, multi-phenomena theory, modeling and simulation at the nanoscale* – 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.

Nanomaterials. The FY 2007 Request includes $57.97 million for discovery of novel nanoscale and nanostructured materials, and at gaining a comprehensive understanding of the properties of nanomaterials (ranging across length scales and including interface interactions). Another focus will be on design and synthesis, in a controlled manner, of nanostructured materials with targeted properties. Research on the discovery, understanding, and control of materials at the nanoscale will be critical to the development and success of innovative technologies, including communications, energy, healthcare, and manufacturing.

Nanoscale devices and systems. The FY 2007 Request includes $50.26 million for R&D that applies the principles of nanoscale science and engineering to create novel, or to improve existing, devices and systems. This includes the incorporation of nanoscale or nanostructured materials to achieve improved performance or new functionality, and developing 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.

Silicon nanotechnology and beyond complementary metal-oxide superconductors (CMOS) is an area of focus. Research will explore ultimate limits to scaling of features and alternative physical principles for devices employed in sensing, storage, communication, and computation. The research activity in this area will help develop innovative technologies, including replacing electron charge as information carrier and bottom-up device assembly technologies at the atomic and molecular levels.

Instrumentation research for nanotechnology. The FY 2007 Request includes $15.0 million for R&D to create new tools needed to advance nanotechnology research and commercialization, including next-generation instrumentation for characterization, measurement, synthesis, and design of materials, structures, devices, and systems.

Nanomanufacturing. The FY 2007 Request includes $27.24 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. R&D aimed at enabling scaled-up, reliable, cost-effective manufacturing of nanoscale materials, structures, devices, and systems. It includes R&D and integration of ultra-miniaturized top-down processes, increasingly complex bottom-up or self-assembly processes, and developing novel concepts for high-rate synthesis and processing of nanostructures and nanosystems.

Major research facilities and instrumentation acquisition. The FY 2007 Request includes $31.85 million for establishment of user facilities, acquisition of major instrumentation, and other activities that develop, support, or enhance the scientific infrastructure for the conduct of nanoscale science, engineering, and technology research and development. It also supports ongoing operations of the

National Nanotechnology Infrastructure Network (NNIN) and Network for Computational Nanotechnology (NCN). The investment will support facilities for 15 ongoing Nanoscale Science and Engineering Centers (NSEC).

Societal Dimensions. The FY 2007 Request includes $59.02 million, an increase of $13.48 million over FY 2006, for various research and other activities that address the broad implications of nanotechnology for society, including benefits and risks, such as:

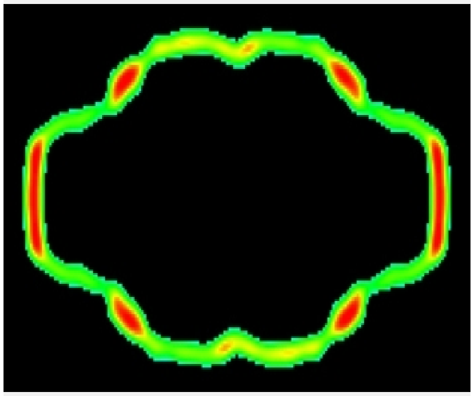
- Research directed at environmental, health, and safety impacts of nanotechnology development and basic research supporting risk assessment of such impacts ($25.65 million). Research will addresses three sources of nanoparticles and nanostructured materials in the environment (in air, water, soil, biosystems, and working environment), as well as the non-clinical biological implications. The safety of manufacturing nanoparticle is investigated in four center/networks: NSEC at Rice University (evolution of manufacturing nanoparticles in the wet environment), NSEC at Northeastern University (occupational safety during nanomanufacturing), NSEC at University of Pennsylvania (interaction between nanomaterials and cells), and National Nanotechnology Infrastructure Network (with two nanoparticle characterization centers at the University of Minnesota and Arizona State University).
- Education-related activities, such as development of materials for schools, curriculum development for nanoscience and engineering, development of new teaching tools, undergraduate programs, technical training, and public outreach ($28.0 million). Two networks for nanotechnology education with national outreach will be supported: The Nanotechnology Center for Learning and Teaching (NCLT) and the Network for Nanoscale Informal Science Education (NISE).
- Research directed at identifying and quantifying the broad implications of nanotechnology for society, including social, economic, workforce, educational, ethical, and legal implications ($5.37 million). The application of nanoscale technologies will stimulate far-reaching changes in the design, production, and use of many goods and services. Factors that stimulate scientific discovery at the nanoscale will be investigated, effective approaches to ensure the safe and responsible development of nanotechnology will be explored and developed, and the potential for converging technologies to improve human performance will be addressed. The *Nanotechnology in Society Network* will become fully operational in FY 2007.

Coordination with Other Agencies

The NSF program is coordinated with 24 departments and agencies through the National Science and Technology Council's subcommittee on Nanoscale Science, Engineering and Technology (NSET). Examples of specific coordination efforts are: Nanomanufacturing (DOD/NIST); Environmental issues (EPA/NIOSH); NSECs, NNIN and NCN centers and networks (DOD/NASA/DOE); simulations in nanoelectronics (DOD/NASA); and research and training activities (NIH).

Recent Research Highlight

► **Vaults: From Biological Mystery to Nanotech Workhorse?** In the nearly two decades since the naturally occurring nano-capsules known as "vaults" were discovered, researchers have found that these hollow, barrel-like structures circulate by the tens of thousands in just about every cell of the human body, as well as in the cells of monkeys, rats, frogs, electric rays and even slime molds. Researchers have also come to believe that these vaults could find a wide range of uses in nanotechnology – even though no one can figure out how nature itself uses them.



A vault particle in cross-section.

At UCLA, for example, researchers have gained a good understanding of the particles' structures and how they assemble themselves out of protein molecules and RNA. By using the standard techniques of biotechnology, vaults may soon be engineered to give them different properties, which could lead to their use as structural elements for nanoscale machines or as switches for nanoscale electrical circuits. Better yet, researchers have shown that vaults can function as nanoscale Trojan Horses, carrying foreign molecules past cellular membranes that are expressly designed to keep such interlopers out. Researchers are now working to bioengineer vaults that will hone in on specific cell surface receptors, so that they can be directed to enter only certain types of cells.

NETWORKING AND INFORMATION TECHNOLOGY R&D

The National Science Foundation is the lead federal agency in the Networking and Information Technology Research and Development (NITRD) Program (www.nitrd.gov). Every NSF directorate is involved in NITRD activities and NSF participates in every NITRD program component area (PCA).

Networking and Information Technology Research and Development Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biological Sciences	$77.00	$77.00	$83.50	$6.50	8.4%
Computer and Information Science and Engineering	490.20	496.41	526.69	30.28	6.1%
Engineering	11.20	11.20	11.20	-	-
Geosciences	14.56	14.56	14.56	-	-
Mathematical and Physical Sciences	77.52	67.82	69.00	1.18	1.7%
Social, Behavioral and Economic Sciences	12.47	12.47	12.47	-	-
Office of Cyberinfrastructure	123.28	127.12	182.42	55.30	43.5%
Office of International Science and Engineering	0.38	-	-	-	N/A
Subtotal, Research and Related Activities	806.61	806.58	899.84	93.26	11.6%
Education and Human Resources	4.06	3.75	3.90	0.15	4.0%
Total, NITRD	$810.67	$810.33	$903.74	$93.41	11.5%

Totals may not add due to rounding.

NSF's FY 2007 request continues strong support for the NITRD Program. The total request of $903.74 million supports research and education in:

- High-end computing infrastructure and applications (HEC I&A) involving advanced computer systems, applications software, and related infrastructure, which are core necessities for cutting-edge discovery across all scientific and engineering fields;
- High-end computing research and development (HEC R&D) activities to optimize the performance of today's high-end computing systems and to develop future generations of systems to meet critical needs;
- Cybersecurity and information assurance (CSIA), a new program component area, focusing on improving the ability of information systems to prevent, resist, respond to, or recover from actions or events that compromise or threaten the availability, integrity, or confidentiality of data of the information systems themselves, or of related services;
- Human-computer interaction and information management (HCI&IM) to increase the benefit of computer technologies to humans, particularly the science and engineering community;
- Large-scale networking (LSN) to enhance high-performance networking, including leading-edge networking technologies and services;
- High-confidence software and systems (HCSS) for systems and verification technologies to assure computer-based system safety, dependability, and correctness;
- Software design and productivity (SDP) leading to fundamental advances in concepts, methods, techniques, and tools for software design; and

- Social, economic, and workforce aspects of IT and IT Workforce Development (SEW) focusing on the nature and dynamics of IT impacts on technical and social systems, interactions between people and IT devices and capabilities, and workforce development needs.

NSF works in close collaboration with other NITRD agencies and participates at the co-chair level in seven of the eight program component coordinating groups. NSF's Assistant Director for Computer and Information Science and Engineering Directorate is co-chair of the NITRD Subcommittee of the National Science and Technology Council's Committee on Technology.

NITRD and Cyberinfrastructure (CI)

A good deal of overlap exists between NSF's NITRD and CI portfolios. The majority - nearly sixty percent - of the agency's NITRD portfolio comprises fundamental research and education in computing supported by the Directorate of Computer and Information Science and Engineering. These NITRD activities represent high-risk, long-term, investments in the computing frontier. At the other end of the NITRD spectrum, some of the agency's NITRD investments are focused on the deployment of state-of-the-art NITRD technologies in service to the broad range of NSF-supported science and engineering disciplines; these NITRD investments are also reported as CI Tools. Examples of projects in this category include the Teragrid, which is supported by the Office of Cyberinfrastructure. NSF also makes research investments in a number of projects and programs that are driven by science and engineering applications, but which require varying degrees of information technology and networking research investments; these activities are reported both as CI and as NITRD.

FY 2007 Areas of Emphasis:

In FY 2007, NSF will emphasize investments in the following areas of NITRD:

High-End Computing R&D: CISE will continue support of the High-End Computing University Research Activity to support innovative research activities aimed at building complex software and tools on top of the operating system for high-end architectures.

High-End Computing Implementation and Applications: The first phase in the acquisition of a leadership-class high performance computing system in the Office of Cyberinfrastructure is included at a level of $50.0 million. Also, several NSF directorates will increase their investments in this area to capitalize on the growing importance of cyberinfrastructure in furthering their research and education goals. For example, MPS will increase activity in modeling and simulation of complex systems, including development of numerical algorithms and software implementations that push the boundaries of computing infrastructure in solving numerical problems that were previously intractable.

Cybersecurity and Information Assurance: CISE will increase support for the Cyber Trust program, which is based on a vision of society in which the computers and networks underlying national infrastructures, as well as in homes and offices, can be relied upon to work – even in the face of cyber attacks. Support will continue for a number of ongoing projects, including one focused on the design and technology for trustworthy voting systems and the other on securing electric power grids.

High Confidence Software and Systems: Funding in this area includes an increase in cybersecurity research funded through the CISE Directorate.

Human Computer Interfaces and Information Management: Funding in this area is increased in recognition of the need to provide responsible stewardship of scientific digital data. NSF will continue to work with the Library of Congress through their newly established Digital Archiving and Long-Term Preservation program (DIGARCH). Digital preservation is of central importance for scientific data.

Social, Economic and Workforce: NSF will continue the Broadening Participation in Computing program aimed at significantly increasing the number of students who are U.S. citizens and permanent residents receiving post secondary degrees in the computing disciplines. Support also will continue for Cyberinfrastructure TEAM (CI-TEAM) projects designed to prepare current and future generations of scientists and engineers to create, advance and exploit cyberinfrastructure.

Recent Research Highlight

► **From "Research Testbed" to "Real LifeTest" in Gulf:** When advanced networking scientists at the University of Nebraska-Lincoln (UNL), Texas A&M, and the Ohio State University wrapped up their normal weekly call in late August 2005 they had no idea that their laboratory work on advanced networking via satellite would so quickly be put to a real life-and-death test. Only a short time later, working with their partners at the American Distance Education Consortium, the Indiana Higher Education Telecommunications System and private sector partner Tachyon, they were developing a plan to get these state-of-the-art communication capabilities into Katrina-ravaged institutions in Louisiana and Mississippi. Working with local emergency responders they established emergency telecommunications support for doctors and local communities. The "collaboratory" of scientists demonstrated that they could quickly move from laboratory to field to broadly impact the affected area.

SELECTED CROSSCUTTING PROGRAMS

NSF crosscutting programs include interdisciplinary programs and programs that are supported by multiple directorates. Examples of major crosscutting activities include the following:

- **ADVANCE:** A budget of $19.72 million for ADVANCE in FY 2007, an increase of $90,000 over the FY 2006 Current Plan, will fund new and continuing efforts to address the systemic barriers to women's full participation in academic science and engineering. Included in the 2007 portfolio will be evaluation and assessment efforts to capture the impact of prior ADVANCE awards and to build upon effective practices, as well as new awards for Partnerships for Adaptation, Implementation, and Dissemination (PAID). PAID awards seek to broaden the impact of institutional transformation efforts and to expand the network of institutions and individuals who are equipped with knowledge and strategies to address institutional factors underlying the underrepresentation of women in academic science and engineering.

- **Faculty Early Career Development (CAREER):** The FY 2007 Request for CAREER totals $149.46 million, an increase of $3.54 million over the FY 2006 Current Plan of $145.92 million. This funding will result in approximately 20 more CAREER awards than in FY 2006. CAREER awards support exceptionally promising college and university junior faculty who are committed to the integration of research and education and who are most likely to become academic leaders.

- **Graduate Fellowships and Traineeships:** The FY 2007 Request provides $218.72 million, an increase of $9.29 million over the FY 2006 Current Plan, for NSF's three flagship graduate fellowship and traineeship programs. This funding will enable NSF to support an estimated 4,665 graduate students.
  - $96.09 million for the Graduate Research Fellowship (GRF) program, an increase of $2.73 million above the FY 2006 Current Plan, will support graduate students in all STEM fields. Funding will support an estimated 2,280 fellows.
  - $66.97 million for the Integrative Graduate Education and Research Traineeship (IGERT) program, an increase of $1.55 million above the FY 2006 Current Plan, will support comprehensive Ph.D. programs that are innovative models for interdisciplinary education and research and that prepare students for academic and non-academic careers. Funding will support an estimated 1,385 IGERT trainees.
  - $55.66 million for the Graduate Teaching Fellowships in K-12 Education (GK-12) program, an increase of $5.01 million above the FY 2006 Current Plan, will strengthen partnerships between higher education institutions and local school districts by providing universities the opportunity to become engaged with a program that features outreach to K-12 schools in a manner that benefits both their teachers and students. Funding will support an estimated 1,000 graduate fellows.

- **Research Experiences for Undergraduates (REU):** The FY 2007 Request for NSF's REU program totals $56.92 million, an increase of $1.10 million above the FY 2006 Current Plan of $55.82 million. The REU program supports active research participation by undergraduate students in any area of research funded by the NSF. It is effective in attracting undergraduate students to graduate study. REU sites involve students in research who might not otherwise have the opportunity, particularly those from institutions where research programs are limited. A significant fraction of the student participants come from outside the host institutions.

- **Research Experiences for Teachers: (RET):** The FY 2007 Request for NSF's RET program totals $8.51 million, an increase of $120,000 above the FY 2006 Current Plan of $8.39 million. Funding will provide pre-service and in-service K-12 teachers with discovery-based learning experiences.

SENSORS AND RELATED RESEARCH

In FY 2007, $20.0 million is requested to support leading edge, frontier research across NSF on sensors and other research that is potentially relevant to the detection of explosives and related threats.

Recent advances in sensor research have yielded innovative applications that have been of tremendous value to our national security, healthcare, environmental safety, and energy resource management. Additional frontier research in areas critical to our Nation will yield similar advances. This is particularly true for the detection of explosives and related threats, including improvised explosive devices (IEDs).

ENG will lead this new NSF-wide effort, in collaboration with other agency efforts, which seeks to advance fundamental knowledge in new technologies for sensors and sensor networks, and in the use of sensor data in control and decision-making across a broad range of applications, particularly those that bear on the prediction and detection of explosive materials and related threats. This research is seen as critical to our Nation's ability to deploy effective homeland security measures, and to protect civilians and our military forces throughout the world.

Sensors Research Related to Prediction

New fundamental research into the scientific and engineering principles of prediction through sensors will enable the recognition of explosives and other threats earlier than current technologies allow. The ultimate goal is to identify and isolate a threat at the point of device assembly and placement. Research toward this goal would include the recognition of emplacement patterns, behavioral pattern recognition from video and other sensing systems, human intelligence and social network analysis of terrorist networks, analysis of communications, modeling and simulation of such activity, and knowledge-management systems.

The key to prediction will be the ability to integrate data from diverse sources, which may include psychology and sociology of terrorists, artificial intelligence, explosive characterization, pattern recognition, and information management – areas in which NSF has long been active.

Specific topics of research may include real-time investigation of the detonation process and mechanisms to initiate detonation in solid explosives. This research will enhance our capabilities in efficient detection, sensing, and control of explosive devices.

Sensor Research Related to Detection

The sensitivity and fine resolution of sensors often determine what can be detected, at what location, and how quickly. This is particularly important for the detection of explosive devices, since the earlier a threat can be identified, the easier it is to address.

Once an explosive device is in place, its detection will rely on scientific and engineering concepts that permit rapid, standoff identification and localization of explosives. This research includes the remote surveillance and possible identification of an explosive's unique characteristics. The purpose is to distinguish real threats in an environment, with minimal to no false alarms. Topics in this category include sensor technologies, signal processing, data fusion, and autonomous system technologies.

Specific areas of research may include the development of new detectors based on a fundamental understanding of animal-sensory systems. An example is an "electronic nose" modeled after the olfactory response in mammals such as dogs. Additional research may go toward the development of new detectors that can identify specific chemical signatures. These may be based on principles such as terahertz spectroscopy, laser ionization, chemical ionization, and low-energy electron attachment.

More broadly, the miniaturization of chemical analyzers is needed. Single-walled nanotubes are especially promising in the miniaturization of electronics and photonics; research is needed on the synthesis and characterization of chemical and electronic materials such as these. Also, in order to maintain active sensors in the field, small reliable power sources are required.

Complementing this sensor research would be advances in tagging and tracing explosives to aid in forensic investigations. There are limited chemical approaches available now because of the difficulty of effectively hiding this information while not interfering with the other chemical and physical properties of the material.

Potential Topical Areas

Under the broad categories of prediction and detection, NSF will look at topical areas that cut across all related studies, and will help identify gaps in research and areas of potential exploitation. Examples of possible topics that will build on previous NSF-supported research include:

- **Engineering of Materials, Concepts and Designs for New Sensors and Sensing Systems.** This topical area emphasizes the engineering of materials and devices that are suitable for applications in technology and environmental observation. Proposed research should lead to sensors that are sensitive, selective, and stable with rapid response times.

- **Environmental Sensors and Sensing Systems.** A unifying theme of this topical area is to stimulate fundamental advances *in situ* and remote sensing systems, with a goal toward observing, modeling and analyzing a wide range of complex environmental materials or compounds, life forms, and processes. Proposed research should leverage recent advances in microelectronics, photonics, telemetry, robotics, wireless communication, sensor networks, and other methods for highly resolved spatial and temporal sensing of physical, biological, and chemical threats.

- **Engineering Applications of Networked Sensors; Interpretation of Data; Responsive Action.** This area addresses system-level application areas. Research issues include: decision and control theory for sensed information; sampling, pattern recognition, and false alarms in sensed data. Additional research will address power-aware sensor networks with self-configuring, self-healing, and self-optimizing capabilities. New research also will incorporate uncertainty and risk into decision making for use with imperfectly sensed data.

- **Information Management of Sensing Systems.** In the area of information management, basic research is needed on innovative approaches to tagging data to facilitate subsequent retrieval, and on compression algorithms useful for transmitting large data files, such as high-resolution image files. Innovative new signal processing techniques and algorithms, together with test bed experiments, are needed for feature extraction of anomalies associated with explosives and related threats activity.

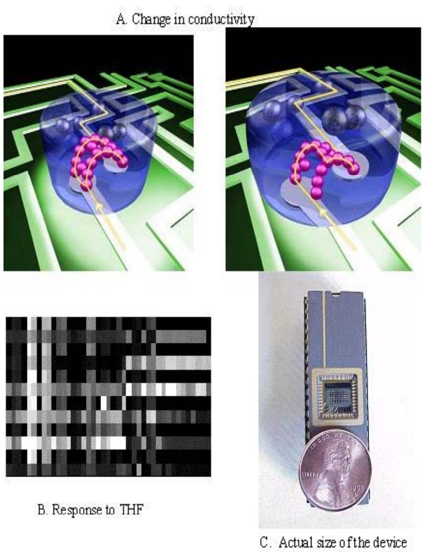
- **Social and Behavioral Science.** The production, distribution, and detonation of explosives involve the coming together of manufactured materials with human beings at particular times and places. Research findings from psychologists, cultural anthropologists, and geographers, can be as critical to successful prevention as understanding physical, chemical, and engineering technical aspects and logistics.

Coordinating Research with the Broader Community

NSF investments will coordinate with and leverage on research currently underway in other areas of the federal government. The U.S. Navy, Department of Energy, and the Department of Defense each have active research into mitigating the dangers from IEDs. Only by integrating all research in the field can effective technologies and systems be deployed.

NSF will be able to use its proven research dissemination and coordination vehicles, such as workshops, focused solicitations, and briefings, to better integrate the research community around this important topic.

Recent Research Highlight



Electronic nose detecting a chemical and a photograph showing the actual size of the device. *Credit: Nathan Lewis, California Institute of Technology*

► **Electronic Nose:** NSF is supporting the development of an artificial "sniffing" device that may rival the extraordinary sensitivity of the canine nose. Such a device would be in great demand for detection of explosives, drugs and other materials. To create the electronic nose, Nathan Lewis and his group at Caltech start by making micro-fabricated devices with surfaces that contain special polymer coatings. When a particular gas is present, it causes the polymer to swell. (Illustration A.) As a result, the electrical conductivity of the device changes, triggering a signal. Arrays of such sensors, depicted at the top of the illustration, can provide the synthetic equivalent of an animal's olfactory system. The pattern of response of the array (B) is different for each type of gas, so identification of the specific substance can be achieved through familiar pattern recognition methods. The devices are small (C) and have already flown on space shuttles to monitor air quality. (MPS)

NATIONAL SCIENCE FOUNDATION CENTERS

NSF supports a variety of individual Centers and Centers programs that contribute to the Foundation's investment in *Ideas*. Centers exploit opportunities in science, engineering, and technology in which the complexity of the research problem or the resources needed to solve the problem require the advantages of scope, scale, change, duration, equipment, facilities, and students that can only be provided by an academic research center.

Centers Funding
(Dollars in Millions)

	Program Initiation (year)	FY 2005 Number of Centers	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Centers for Analysis and Synthesis	1995	2	7.07	6.39	6.46	0.07	1.1%
Chemistry Centers	1998	6	3.00	1.48	3.00	1.52	102.7%
Earthquake Engineering Research Centers	1988	3	6.00	6.00	-	-6.00	-100.0%
Engineering Research Centers	1985	19	62.31	63.42	62.79	-0.63	-1.0%
Materials Centers	1994	29	52.41	53.66	55.70	2.04	3.8%
Nanoscale Science and Engineering Centers	2001	15	36.40	37.21	37.35	0.14	0.4%
Science and Technology Centers	1987	13	49.65	62.38	67.48	5.10	8.2%
Science of Learning Centers	2003	4	19.83	22.71	27.00	4.29	18.9%
Total, Centers		91	$236.67	$253.25	$259.78	$6.53	2.6%

Totals may not add due to rounding.

In 2005, NSF's senior management updated principles that govern investments in Centers. This review reaffirmed the Foundation's commitment to Centers funding and the objective that Centers must push towards research frontiers not normally attainable through individual investigations.

As part of this analysis, all directorates were asked to review programs reported as Centers against the updated principles. Those that did not meet the stated principles were recharacterized and funding was moved to the Fundamental Science and Engineering investment category. The outcome was presented to and accepted by the National Science Board during their August 2005 meeting.

Centers Recharacterization
(Dollars in Millions)

	FY 2005 Current Plan	Percent of 2005 Total Budget	Percent of 2005 R&RA Budget
Pre-Centers assessment	$351	6.4%	8.3%
Amount recharacterized	$119	2.2%	2.8%
Post-Centers assessment	$232	4.2%	5.5%
Percent change in Centers-identified programs	-34%		

Some of the major categories of research no longer characterized as Centers include Long Term Ecological Research (LTER) projects, Plant Genome research, Math Research Institutes, and Children's Research Initiative programs. Among the key elements of the updated principles are that NSF Centers are merit-reviewed, with one of the review criteria being the added value of supporting frontier research using the center mode of support versus the individual investigator mode, and that NSF's support for Centers is of limited duration – a maximum of 10 years, with a built-in phase-out period.

CENTERS DESCRIPTIONS

Centers for Analysis and Synthesis (BIO)
The National Center for Ecological Analysis and Synthesis (NCEAS) 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. The Center supports in-house working groups, post-doctoral associates, and sabbatical visits by senior scientists, all on a competitive basis. A Science Advisory Board serves to screen proposals annually.

The National Evolutionary Synthesis Center (NESCent) at Duke University, North Carolina State University, and the University of North Carolina at Chapel Hill provides mechanisms to foster synthetic, collaborative, cross-disciplinary studies in evolutionary biology. This plays a pivotal role in the further unification of the biological sciences as it draws together knowledge from disparate biological fields and increases our general understanding of biological design and function. The Center has a critical role in organizing and synthesizing evolutionary knowledge that is useful to policy makers, government agencies, educators, and society. The established Center will continue to develop new tools and cross-disciplinary standards for management of biological information and meta-information, support data analysis capabilities with broad utility across the biological sciences, host workshops bringing together scientists from a variety of disciplines to integrate various approaches to the field, and begin to host and curate databases important to evolutionary synthesis.

Chemistry Centers (MPS)
The Chemical Bonding Centers (CBCs) are designed to support major, long-term "big questions" in basic chemical research. Problems to be addressed are high-risk but with potentially high scientific and societal impact. CBCs are expected to be agile, responding to scientific opportunities as they arise, and to take advantage of cyberinfrastructure. These centers provide diverse ways for groups of researchers in the chemical sciences to work collaboratively on challenging problems of fundamental and strategic importance. These problems include the activation of strong bonds as a means to decrease energy requirements in chemical processing, the design of self-replicating biological molecules with the capability of evolving enhanced function, and the rational synthesis of "smart materials". Additional centers are fabricating molecular machines that are powered by chemical bond formation, investigating the efficient storage of solar energy in synthetic molecules, and probing the inner workings of molecular events with unprecedented spatial and temporal resolution.

Earthquake Engineering Research Centers (ENG)
Earthquake Engineering Research Centers focus on reducing earthquake losses, integrating research and education, and developing partnerships with industry and public agencies responsible for earthquake hazard mitigation. Funding for these Centers will sunset as planned in FY 2006.

Engineering Research Centers (ENG)
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 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 collaborative 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 among pre-college students and their teachers; several have sites at local museums to educate the general public about engineering and technology.

Materials Centers (MPS)
Materials Research Science and Engineering Centers (MRSECs) support interdisciplinary materials research addressing fundamental problems of intellectual and strategic importance. They support shared experimental facilities, place strong emphasis on the integration of research and education at all levels, and provide support to stimulate emerging areas of materials research. The MRSECs feature cutting-edge materials research in areas such as polymers, biomimetic and biomolecular materials, magnetic and ferroelectric materials, nanoscale materials, electronic and photonic materials, structural materials, and organic systems and colloids.

The MRSECs have strong links to industry and other sectors. MRSECs also involve research and educational partnerships among academic institutions in the U.S. as well as international partnerships. The 2005 MRSEC competition yielded two new centers devoted to biotechnology and materials interfaces, respectively. Three existing centers will be phased out.

Nanoscale Science and Engineering Centers (multi-directorate)
As part of the multi-agency National Nanotechnology Initiative, NSF first funded these Centers in FY 2001; additional Centers have been added since that time. 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. Together they provide coherence and a long-term outlook to U.S. nanotechnology research and education. Support will be provided for education and outreach programs from K-12 to the graduate 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.

Science and Technology Centers (multi-directorate)
NSF’s Science and Technology Centers (STC) Integrative Partnerships Program supports discovery and 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.

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.

Science of Learning Centers (multi-directorate)
NSF's investment builds on the Foundation's support for multidisciplinary research that advances fundamental knowledge about the science of learning. Science of Learning Centers (SLC) are built around a unifying research focus and incorporate a diverse, multidisciplinary environment involving appropriate partnerships with academia, industry, international partners, all levels of education, and other public and private entities. Funding is designed to support a diverse portfolio of research, providing leadership across a broad range of science and engineering approaches to the science of learning research.

FY 2005 Estimates for Selected Centers

(Dollars in Millions)

	Number of Participating Institutions	Number of Partners	Total NSF Support	Total Leveraged Support	Number of Participants
Centers for Analysis and Synthesis	4	20	$7	$2	736
Chemistry Centers	53	19	$3	$4	269
Earthquake Engineering Research Centers	65	155	$6	$10	1,130
Engineering Research Centers and Groups	280	482	$62	$72	8,310
Materials Centers	103	325	$52	$42	5,274
Nanoscale Science and Engineering Centers	130	269	$36	$16	1,630
Science and Technology Centers[1]	94	306	$50	$28	2,118
Science of Learning Centers	20	11	$20	$8	366

[1] Statistics reported for STCs are for 2004 only. Information is not yet available for new Centers funded at the end in FY 2005.

Number of Participating Institutions: all academic institutions that participate in activities at the centers.

Number of Partners: total number of non-academic participants, including industry, states, and other federal agencies.

Total Leveraged Support: funding for centers from sources other than NSF.

Number of Participants: the total number of people who use center facilities, not just persons directly supported by NSF.

Centers Supported by NSF in FY 2005

Center	Institution	State
Centers for Analysis and Synthesis		
National Center for Ecological Analysis and Synthesis (NCEAS)	U of California-Santa Barbara	CA
National Evolutionary Synthesis Center (NESCent)	Duke, NC State, U of N. Carolina	NC
Chemistry Centers		
Activation and Transformation of Strong Bonds	U of Washington	WA
Chemical Design of Materials	U of California-Santa Barbara	CA
Chemistry at the Space:Time Limit: Time Resolved Nonlinear Spectroscopy of Elementary Chemical Events	U of California-Irvine	CA
Center for Molecular Cybernetics	Columbia	NY
Darwinian Chemical Systems	Mass. General Hospital	MA
Powering the Planet: A Chemical Bonding Center for the Direct Conversion of Sunlight into Chemical Fuel	California Institute of Tech	CA
Earthquake Engineering Research Centers		
Mid-America Earthquake Center	U of Illinois-Champaign-Urbana	IL
Multidisciplinary Center for Earthquake Engineering Research	State U of NY-Buffalo	NY
Pacific Earthquake Engineering Research Center	U of California-Berkeley	CA
Engineering Research Centers		
Advanced Engineering Fibers and Films	Clemson	SC
Bioengineering Educational Technology	Vanderbilt	TN
Biomimetic Microelectronic Systems	U of Southern California	CA
Biotechnology Process Engineering	Mass Institute of Tech	MA
Collaborative Adaptive Sensing of the Atmosphere	U of Mass-Amherst	MA
Computer-Integrated Surgical Systems and Technologies	Johns Hopkins	MD
Engineered Biomaterials	U of Washington	WA
Engineering of Living Tissue	Georgia Institute of Tech	GA
Environmentally Beneficial Catalysis	U of Kansas	KS
Environmentally Benign Semiconductor Manufacturing	U of Arizona	AZ
Extreme Ultraviolet Science and Technology	Colorado State	CO
Integrated Media Systems	U of Southern California	CA
Low Cost Electronic Packaging	Georgia Institute of Tech	GA
Neuromorphic Systems Engineering	California Institute of Tech	CA
Particle Science & Technology	U of Florida	FL
Power Electronic Systems	Virginia Tech	VA
Reconfigurable Machining Systems	U of Michigan	MI
Subsurface Sensing and Imaging Systems	Northeastern	MA
Wireless Integrated MicroSystems	U of Michigan	MI
Materials Centers		
Center for Complex Materials	Princeton	NJ
Center for Materials for Information Science	U of Alabama	AL
Center for Materials Research	Cornell	NY
Center for Materials Science and Engineering	Mass Institute of Tech	MA
Center for Micro- and Nanomechanics of Materials	Brown	RI
Center for Multifunctional Nanoscale Materials Structures	Northwestern	IL
Center for Nanoscopic Materials Design	U of Virginia	VA
Center for Nanomagnetic Structures	U of Nebraska	NE
Center for Nanoscale Science	Pennsylvania State	PA
Center for Nanostructured Interfaces	U of Wisconsin	WI
Center for Polymer Science and Engineering	U of Massachusetts	MA
Center for Polymers at Engineered Interfaces	SUNY-Stony Brook, CUNY, Polytech	NY

Center for Polymer Interfaces and Macromolecular Assemblies	Stanford, UC-Davis, IBM	CA
Center for Research on Interface Structures and Phenomena	Yale	CT
Center for Response-Driven Polymeric Films	U of Southern Mississippi	MS
Center for Science and Engineering of Materials	California Institute of Tech	CA
Center for Semiconductor Physics in Nanostructures	U of Oklahoma, U of Arkansas	OK, AR
Center for Thermal Spray Research	SUNY-Stony Brook	NY
Center on the Science and Engineering of Magnetoelectronics	Johns Hopkins	MD
Ferroelectric Liquid Crystals Materials Research Center	U of Colorado-Boulder	CO
Genetically Engineered Materials Science and Engineering Center	U of Washington	WA
Laboratory for Research on the Structure of Matter	U of Pennsylvania	PA
Materials Research Center	U of Chicago	IL
Materials Research Center	Harvard	MA
Materials Research Science and Engineering Center	U of California-Santa Barbara	CA
Materials Research Science and Engineering Center	U of Maryland	MD
Materials Research Science and Engineering Center	U of Minnesota	MN
Materials Research Science and Engineering Center	Carnegie Mellon	PA
Materials Research Science and Engineering Center	Columbia	NY
Nanoscale Science and Engineering Centers		
Affordable Nanoengineering of Polymer Biomedical Devices	Ohio State	OH
High Rate Nanomanufacturing	Northeastern, U of New Hampshire, U of Mass-Lowell	MA
Integrated Nanomechanical Systems	U of Calif-Berkeley, Cal Tech, Stanford, U of Calif-Merced	CA
Molecular Function at the Nano/Bio Interface	U of Pennsylvania	PA
Integrated Nanopatterning and Detection Technologies	Northwestern	IL
Probing the Nanoscale	Stanford, IBM	CA
Nanoscale Systems in Information Technologies	Cornell	NY
Science of Nanoscale Systems and their Device Applications	Harvard	MA
Templated Synthesis and Assembly at the Nanoscale	U of Wisconsin-Madison	WI
Electronic Transport in Molecular Nanostructures	Columbia	NY
Nanoscience in Biological and Environmental Engineering	Rice	TX
Directed Assembly of Nanostructures	Rensselaer Polytechnic Inst	NY
Center for Integrated and Scalable Nanomanufacturing	U of California-Los Angeles	CA
Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems	U of Illinois-Champaign-Urbana	IL
Nanotechnology in Society Network	Ariz St, U of Calif-Berkeley, U of Southern Calif, Harvard	AZ, CA, MA
Science and Technology Centers		
Adaptive Optics	U of California-Santa Cruz	CA
Advanced Materials for Water Purification	U of Illinois	IL
Behavioral Neuroscience	Georgia State	GA
Biophotonics Science and Technology	U of California-Davis	CA
Center for Remote Sensing of Ice Sheets	U of Kansas	KS
Earth Surface Dynamics	U of Minnesota	MN
Embedded Networked Sensing	U of California-Los Angeles	CA
Environmentally Responsible Solvents and Processes	U of North Carolina	NC
Integrated Space Weather Modeling	Boston U	MA
Materials and Devices for Information Technology Research	U of Washington	WA
Nanobiotechnology	Cornell	NY
Sustainability of Semi-Arid Hydrology and Riparian Areas	U of Arizona	AZ
Ubiquitous Secure Technology	U of California-Berkeley	CA

Science of Learning Centers

C-CEN - Center for Cognitive and Educational Neuroscience	Dartmouth College	NH
CELEST - A Center for Learning in Education, Science, & Tech.	Boston U	MA
The LIFE Center - Learning in Formal and Informal Environments	U of Washington	WA
Pittsburgh Science of Learning Center - Studying Robust Learning with Learning Experiments in Real Classrooms	Carnegie Mellon	PA

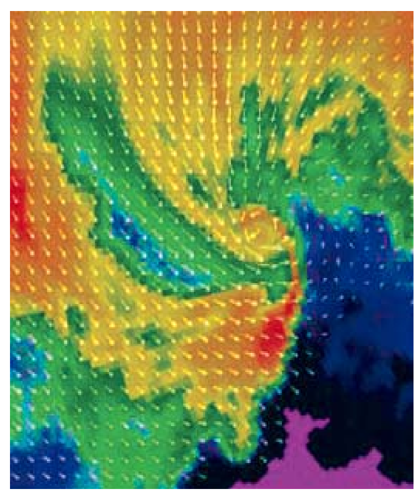
Recent Research Highlights

Aplysia califonica. *Photo courtesy of Columbia University.*

► **Sea Slug Mixes Ingredients to Produce a Chemical Defense with Antimicrobial Properties:** A team of researchers from the NSF-supported Center for Behavioral Neuroscience (CBN) has found that when the sea slug *Aplysia* is threatened by predators, it defends itself by drawing on a hidden stash of two ingredients that combine to create a potent ink. The slug stores the normally inert chemicals separately in two glands and then releases them simultaneously into its mantle cavity at the precise time when they are needed. One component of the ink also has strong antibacterial properties and is being studied for its potential applications by the healthcare and marine industries. CBN is a consortium of eight metro Atlanta colleges and universities, led by Georgia State University, that focuses on increasing our understanding of the neurobiology of complex social behaviors.

Other CBN studies have led to breakthrough treatments for anxiety-related disorders and a new understanding of the role neurochemicals play in the formation of social bonds between animals. In addition to research, CBN has a comprehensive education program designed to improve science literacy and attract more women and underrepresented minorities to neuroscience programs.

► **Radar Algorithms for Automatically Detecting Tornadoes:** Using data from networks of low-power Doppler weather radars, researchers have developed the first algorithms for dynamically detecting tornadoes. The Engineering Research Center (ERC) for Collaborative Adaptive Sensing of the Atmosphere (CASA), headquartered at the University of Massachusetts-Amherst, designed the algorithms to distinguish tornadoes from transient but intense low-altitude shear regions within severe storms. For the first time, CASA's radars can now see close to the ground, thus locating a tornado and determining its intensity.



Simulated data processed by an algorithm. *Credit: ERC for Collaborative Adaptive Sensing of the Atmosphere.*

The algorithms reconstruct a three-dimensional wind field based on estimates from multiple Doppler radars. Because real data are not yet available from new CASA radars soon to be deployed in Oklahoma, high-resolution computer simulations of storms and their associated tornadoes are being used in the interim. This image shows one such simulated data set processed by the algorithm, with the tornado located in the region of swirling flow in the right-center portion of the image.

PERFORMANCE INFORMATION

This chapter provides supporting information on the performance activities used in developing NSF's FY 2007 Budget Request. The NSF Strategic Plan for FY 2003-2008 established the overall framework for evaluating NSF's performance through the Ideas, Tools, People, and Organizational Excellence strategic goals. Each of these strategic goals consists of three to four investment categories that are evaluated through the Program Assessment Rating Tool, or PART. The two investment categories assessed for this budget cycle were Fundamental Science and Engineering under the Ideas goal, and Federally Funded Research and Development Centers under the Tools goal.

National Science Foundation
By Strategic Outcome Goal and Investment Category
(Dollars in Millions)

	FY 2005 Actuals	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Percent
Ideas					
Fundamental Science and Engineering	$2,283.43	$2,270.88	$2,413.72	$142.84	6.3%
Centers Programs	236.67	253.25	259.78	6.53	2.6%
Capability Enhancement	218.98	224.18	241.52	17.34	7.7%
	$2,739.08	$2,748.31	$2,915.02	$166.71	6.1%
Tools					
Facilities	$475.13	$514.32	$580.30	$65.98	12.8%
Infrastructure and Instrumentation	466.04	479.40	565.30	85.90	17.9%
Polar Tools, Facilities and Logistics	278.16	306.95	345.56	38.61	12.6%
Federally-Funded R&D Centers	182.10	187.45	194.08	6.63	3.5%
	$1,399.44	$1,488.12	$1,685.24	$197.12	13.2%
People					
Individuals	$522.22	$496.36	$519.84	$23.48	4.7%
Institutions	145.28	146.92	146.54	-0.38	-0.3%
Collaborations	394.69	388.38	404.04	15.66	4.0%
	$1,062.19	$1,031.65	$1,070.42	$38.77	3.8%
Organizational Excellence	$280.07	$313.09	$349.53	$36.44	11.6%
Total, NSF	$5,480.77	$5,581.17	$6,020.21	$439.04	7.9%

Totals may not add due to rounding.

For NSF and other federal agencies with significant R&D portfolios, assessment activities are required to draw heavily upon the R&D Investment Criteria established by OMB and the Office of Science and Technology Policy. These three criteria, Relevance, Quality, and Performance are described below and are reflected in each of the directorate and office narratives throughout this Budget Request.

- Relevance: R&D programs must be able to articulate *why* this investment is important, relevant, and appropriate.
- Quality**:** R&D programs must justify *how* funds will be allocated to ensure quality R&D.
- Performance: R&D programs must be able to monitor and document *how well* the investment is performing.

NSF Strategic Goals and Objectives

Ideas

FY 2007 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 underrepresented 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;
- 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; and
- Support innovative research on learning and teaching that provides a scientific basis for improving science, technology, engineering and mathematics education at all levels.

Tools

FY 2007 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; and
- Support research that advances instrument technology and leads to the development of next-generation research and education tools.

People

FY 2007 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; and
- 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.

<u>Organizational Excellence</u>

FY 2007 Strategic Goal for Organizational Excellence: NSF will demonstrate significant achievement for all 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; and
- 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.

Means and Strategies for Success for NSF Goals in FY 2007

To achieve its strategic outcome goals of Ideas, Tools, People, and Organizational Excellence, NSF supports the best ideas generated by the science and engineering community through awarding merit-based grants and cooperative agreements and encourages partnerships and cooperative research efforts among investigators, institutions, disciplines, and sectors and across international boundaries. The Foundation develops and supports a high-quality, balanced award portfolio that incorporates NSF's core disciplines, priority investments, and new and emerging opportunities, including those that have the potential for transformation. NSF also broadens the impacts of research and education activities by increasing the diversity of individuals and institutions supported.

NSF specifically addresses the <u>Ideas</u> goal through expanded investments in fundamental science and engineering and support of policy-relevant programs to establish the foundations for an evidence-based "science of science policy." NSF also supports the broad interagency and interdisciplinary activities coordinated by the National Science and Technology Council.

NSF specifically addresses the <u>Tools</u> goal through investment in broadly accessible, state-of-the-art infrastructure to meet major research challenges while developing and implementing improvements for selection, management, and oversight of large facility projects. Another primary strategy for NSF is to acquire a leadership-class high performance computing system that will contribute to a world-class computing environment.

NSF specifically addresses the <u>People</u> goal by strengthening the K-12 education portfolio through integrating and consolidating existing programs. NSF will also improve science education at the middle and high school levels and increase support for graduate teaching fellowships.

NSF specifically addresses the <u>Organizational Excellence</u> goal by effectively managing the process of external merit review of an increasingly complex number of proposals; employing new and emerging technologies to improve business applications; supporting continuous learning for staff through training courses and participation in professional meetings; and improving award management and oversight through site visits and outreach to scientific and engineering organizations.

Resources Required

Each of NSF's strategic goals can be achieved with the staff and budgetary resources as presented in the FY 2007 Budget Request.

Prior Year Results for NSF's Strategic Goals

Each of NSF's goals is a continuation of the FY 2006 Strategic Goal based on the NSF Strategic Plan for FY 2003-2008. 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 goals. NSF was successful in achieving the annual performance goal associated with the Ideas, Tools, and People strategic outcomes in FY 2001-2005. Evaluation of achievement includes input from the external Advisory Committee for GPRA Performance Assessment (AC/GPA).

The Organizational Excellence goal is a continuation of the FY 2006 Strategic Goal developed based on the NSF Strategic Plan FY 2003 through FY 2008. NSF achieved the goal in FY 2005. Evaluation of achievement included input from two groups of external experts: the AC/GPA and the Advisory Committee for Business and Operations. More information about the AC/GPA and its reports may be found at www.nsf.gov/about/performance/acgpa/index.jsp.

Quality

Quality is one of the three R&D Investment Criteria for agencies supporting research. Under this criterion, programs maximize the quality of the R&D they fund through the use of a clearly stated, defensible method for awarding a significant majority of their funding. For NSF, this method is the merit review process. In FY 2005, the percent of research funds that were allocated to projects that undergo external merit review was 90 percent.

The review infrastructure in place at NSF is expert-driven, of high quality, independent, and continual. The evaluation process is a true collaboration between the agency and the research and education community. Evaluations of individual proposals are based on criteria established by the National Science Board, and are conducted by reviewers selected from pools of national and international experts in each field. Each year NSF receives over 40,000 new proposals and subjects virtually all of them to an external merit review. In FY 2005, some 41,000 outside experts provided about 250,000 separate reviews to assist NSF in the evaluation of proposals, submitted to the Foundation's nine directorates and offices, covering a wide variety of topics.

The Quality criterion also requires programs to assess and report on the quality of current and past R&D. Independent evaluation of each of the agency's programs is also critical to ensuring that the focus of research investments continues to be at the frontier of science and engineering. For the past 27 years, NSF has convened external experts to analyze the wide range of programs throughout the Foundation. These Committees of Visitors (COVs) periodically review the managerial stewardship of a specific program or cluster of programs, compare plans with progress made, and evaluate outcomes to determine whether the research contributes to NSF mission and goals. The COVs also provide recommendations to NSF staff to guide future program directions.

Each COV report is presented to the respective directorate's Advisory Committee (AC) for approval. The AC is composed of scientists, engineers, and educators from academe, industry, and other government agencies. These committees work with NSF management to determine which research directions to pursue while assessing the quality and integrity of current program operations. The committees also provide context on how the results contribute to the agency's mission and strategic goals.

At the Foundation-wide level, performance evaluation is conducted by the Advisory Committee for GPRA Performance Assessment. The Committee meets annually to assess results for indicators associated with the strategic outcome goals of Ideas, Tools, and People, and the merit review indicator for the Organizational Excellence goal. The Committee also comments on the quality and relevance of award portfolios and on high risk/transformative research and education awards. The Committee's report is incorporated into the annual Performance and Accountability Report.

Program Assessment Rating Tool (PART)

NSF used the Program Assessment Rating Tool to assess two of its investment categories to inform the FY 2007 budget decision-making process. These PARTs assessed the Fundamental Science and Engineering investment category and the Federally Funded Research and Development Centers investment category. Both of these programs were rated "effective." Since PART evaluations began, each of the ten NSF programs assessed has received the highest rating. The remaining three investment categories, Capability Enhancement, Centers, and Infrastructure and Instrumentation, will be assessed for and reported in the FY 2008 Budget Request.

Fundamental Science and Engineering (FSE), NSF's largest investment category, comprises the broad, core set of research activities that ensure the vitality of a broad array of scientific and engineering fields needed for the United States to maintain leadership in science and engineering. FSE investments support the best new ideas generated by scientists and engineers working at the forefront of discovery. These investments are extremely important to invigorate the research community, since they promote emergence of new ideas and fields, especially in areas where disciplines are blurred, peer consensus is nascent, and new technologies emerge. Investments in these activities ensure the vitality of a broad array of scientific and engineering fields for the U.S. leadership in science and engineering.

Federally Funded Research and Development Centers (FFRDCs) support 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. NSF's FFRDCs are uniquely positioned to provide capabilities and state-of-the-art instrumentation to probe fundamental questions in science and/or to address pressing scientific and technological issues facing the Nation and the international community. The five centers designated as FFRDCs are the National Astronomy and Ionosphere Center, the National Center for Atmospheric Research, the National Optical Astronomy Observatory/National Solar Observatory, the National Radio Astronomy Observatory, and the Science and Technology Policy Institute.

Detailed PART results are available at www.whitehouse.gov/omb/budget/fy2006/. The schedule for PART activities is shown below.

Schedule for PART Activities

Fiscal Year	Investment Category	Rating
FY 2008:	Capability Enhancement (Ideas)	
	Centers (Ideas)	
	Infrastructure and Instrumentation (Tools)	
FY 2007:	Fundamental Science and Engineering (Ideas)	Effective
	Federally Funded Research and Development Centers (Tools)	Effective
FY 2006:	Biocomplexity in the Environment (Priority Area, Ideas)	Effective
	Institutions (People)	Effective
	Collaborations (People)	Effective
	Polar Tools, Facilities and Logistics (Tools)	Effective
FY 2005:	Nanoscale Science and Engineering (Priority Area, Ideas)	Effective
	Information Technology Research (Priority Area, Ideas)	Effective
	Individuals (People)	Effective
	Facilities (Tools)	Effective

Annual Performance Goals

NSF has developed several annual performance goals to measure its progress toward its strategic goals. The annual goals relate to time to decision, graduate students, broadening institutional participation, and facility efficiency. The first goal, time to decision, is a long-standing Foundation-wide goal. The annual performance goal is: *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.* The chart below indicates results for FY 2002-2005 and targets for FY 2006 and FY 2007.

Time-to-Decision (NSF-Wide)	
FY 2002 Result	74%
FY 2003 Result	77%
FY 2004 Result	77%
FY 2005 Result	76%
FY 2006 Target	*70%*
FY 2007 Target	*70%*

Several of NSF's PART programs have adopted the time-to-decision goal for their individual programs. These PART goals include a quality component that is based on a review by the Advisory Committee for GPRA Performance Assessment. The chart below indicates results for FY 2002-2005 and targets for FY 2006 and FY 2007.

Time-to-Decision (by PART program)						
	Individuals	**Institutions**	**Collaborations**	**Nanoscience Priority Area**	**Biocomplexity Priority Area**	**Fundamental Science and Engineering**
FY 2002 Result	83%	74%	82%	78%	74%	74%
FY 2003 Result	84%	80%	92%	46%	83%	80%
FY 2004 Result	74%	83%	82%	46%	61%	83%
FY 2005 Result	78%	76%	82%	73%	66%	73%
FY 2006 Target	*70%*	*70%*	*70%*	*70%*	*70%*	*70%*
FY 2007 Target	*70%*	*70%*	*70%*	*70%*	*70%*	*70%*

The number of graduate students supported through NSF's three primary fellowship and traineeship programs is a key measure of the Agency's People goal. The annual performance goal is: *Maintain a high number of graduate students funded through fellowships or traineeships from Graduate Research Fellowships (GRF), Integrative Graduate Education and Research Traineeships (IGERT), or Graduate Teaching Fellowships (GK-12).* Funding at the FY 2007 request level will support an estimated 4,665 graduate students. The following chart indicates the results for FY 2002-2005 and the targets for FY 2006 and FY 2007.

Number of Graduate Students	
FY 2002 Result	3,623
FY 2003 Result	4,046
FY 2004 Result	4,628
FY 2005 Result	4,641
*FY 2006 Target**	*4,525*
FY 2007 Target	*4,665*

* The FY 2006 number is revised from the FY 2006 Congressional Budget Request to report only graduate students directly funded. Previous results included all students participating in the GK-12 program.

Another annual performance measure, broadening institutional participation, has been adopted by several PART programs. NSF considers broadening institutional participation to be important in increasing the scope of ideas brought forward and that increasing the number of proposals from such institutions reaches a broader group of all researchers, including women and underrepresented minorities at the graduate, postdoctoral, and faculty levels. The annual performance goal for three of the PART programs is: *Increase or maintain the percentage of proposals received from academic institutions not in the top 100 of NSF funding recipients for the Institutions, Collaborations, and Fundamental Science and Engineering investment categories.* The chart below indicates results for FY 2002-2005 and targets for FY 2006 and FY 2007.

Broadening Participation Measure			
	Institutions	**Collaborations**	**Fundamental Science and Engineering**
FY 2002 Result	66%	62%	29%
FY 2003 Result	70%	61%	29%
FY 2004 Result	68%	61%	30%
FY 2005 Result	71%	49%	31%
FY 2006 Target	*73%*	*63%*	*31%*
FY 2007 Target	*73%*	*63%*	*31%*

Two annual performance goals are included for the Facilities PART program. These goals ensure that investments in development and construction of state-of-the-art facilities and platforms are implemented consistently with planned cost and schedule. The first goal, facility construction, is: *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 2007 that have a total project cost of at least $5.0 million. The following chart indicates results for FY 2002-2005 and targets for FY 2006 and FY 2007 for the Facility Construction goal.

Facility Construction	
FY 2002 Result	90%
FY 2003 Result	88%
FY 2004 Result	88%
FY 2005 Result	79%
FY 2006 Target	*90%*
FY 2007 Target	*90%*

The second goal, facility operations, is: *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 $8 million in annual operations and maintenance support. The chart below indicates results for FY 2002-2005 and targets for FY 2006 and FY 2007 for the Facility Operations goal.

Facility Operations	
FY 2002 Result	84%
FY 2003 Result	87%
FY 2004 Result	89.70%
FY 2005 Result	100%
FY 2006 Target	*90%*
FY 2007 Target	*90%*

PROPOSED FY 2007 APPROPRIATIONS LANGUAGE

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; acquisition of aircraft; and authorized travel; $4,665,950,000, to remain available until September 30, 2008, of which not to exceed $485,000,000 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: *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. *(Science Appropriations Act, 2006.)*

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, authorized travel, and rental of conference rooms in the District of Columbia, $816,220,000, to remain available until September 30, 2008. *(Science Appropriations Act, 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, $240,450,000, to remain available until expended. *(Science Appropriations Act, 2006.)*

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; $281,822,000: *Provided,* That contracts may be entered into under ``Salaries and Expenses'' in fiscal year 2007 for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year. *(Science Appropriations Act, 2006.)*

OFFICE OF INSPECTOR GENERAL

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, as amended, $11,860,000, to remain available until September 30, 2008. *(Science Appropriations Act, 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 (42 U.S.C. 1863) and Public Law 86-209 (42 U.S.C. 1880 et seq.), $3,910,000: *Provided*, That not more than $9,000 shall be available for official reception and representation expenses. *(Science Appropriations Act, 2006.)*

SUMMARY OF FY 2007 BUDGET BY APPROPRIATION AND ACTIVITY

(DOLLARS IN MILLIONS)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	CHANGE OVER FY 2006 Amount	CHANGE OVER FY 2006 Percent
RESEARCH AND RELATED ACTIVITIES					
Biological Sciences	$576.78	$576.69	$607.85	$31.16	5.4%
Computer and Information Science and Engineering	490.20	496.41	526.69	30.28	6.1%
Engineering	557.09	580.92	628.55	47.63	8.2%
Geosciences	697.17	702.83	744.85	42.02	6.0%
Mathematical and Physical Sciences	1,069.36	1,085.45	1,150.30	64.85	6.0%
Social, Behavioral and Economic Sciences	196.80	199.91	213.76	13.85	6.9%
Office of International Science and Engineering[1]	43.38	34.52	40.61	6.09	17.6%
Office of Cyberinfrastructure	123.40	127.12	182.42	55.30	43.5%
U.S. Polar Research Programs	278.27	322.68	370.58	47.90	14.8%
U.S. Antarctic Logistical Support Activities	70.26	66.66	67.52	0.86	1.3%
Integrative Activities	130.92	137.12	131.37	-5.75	-4.2%
Arctic Research Commission	1.19	1.17	1.45	0.28	23.9%
Subtotal R&RA	$4,234.82	$4,331.48	$4,665.95	$334.47	7.7%
Unobligated Balance Available Start of Year	-6.55				
Unobligated Balance Available End of Year	7.06				
Recoveries of Prior Year Obligations	-6.09				
Adjustments to Prior Year Accounts	1.51				
Unobligated Balance Lapsing	-0.78				
Reductions Pursuant to P.L. 108-199, P.L. 109-148 and P.L. 108-272	34.04	56.04			
Subtotal R&RA	$4,264.01	$4,387.52	$4,665.95	$278.43	6.3%
Transferred from other funds	-9.42				
Appropriation Total	$4,254.59	$4,387.52	$4,665.95	$278.43	6.3%
EDUCATION AND HUMAN RESOURCES[2]					
EPSCoR	$93.35	$98.72	$100.00	$1.28	1.3%
Research on Learning in Formal and Informal Settings	238.76	215.16	215.00	-0.16	-0.1%
Undergraduate Education	237.52	211.71	196.80	-14.91	-7.0%
Graduate Education	154.75	153.02	160.57	7.55	4.9%
Human Resource Development	119.16	118.08	143.85	25.77	21.8%
Subtotal EHR[3]	$843.54	$796.69	$816.22	$19.53	2.5%
Unobligated Balance Available Start of Year	-1.41				
Unobligated Balance Available End of Year	0.40				
Recoveries of Prior Year Obligations	-1.29				
Adjustments to Prior Year Accounts	-				
Unobligated Balance Lapsing	0.18				
Reductions Pursuant to P.L. 108-199, P.L. 109-148 and P.L. 108-272	6.79	10.31			
Appropriation Total	$848.21	$807.00	$816.22	$9.22	1.1%

[1] OISE FY 2005 Actual includes $9.42 million provided to NSF by the U.S. Department of State for an award to the U.S. Civilian Research and Development Foundation.
[2] EHR FY 2005 Actual and FY 2006 Current Plan reflect proposed FY 2007 structure of programs.
[3] Excludes $25.95 million in obligations in FY 2005 and an estimated $100.0 million in FY 2006 and FY 2007 from H-1B Nonimmigrant Petitioner Fees.

SUMMARY OF FY 2007 BUDGET BY APPROPRIATION AND ACTIVITY

(DOLLARS IN MILLIONS)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	CHANGE OVER FY 2006 Amount	CHANGE OVER FY 2006 Percent
MAJOR RESEARCH EQUIPMENT & FACILITIES CONSTRUCTION	$165.14	$190.88	$240.45	$49.57	26.0%
Unobligated Balance Available Start of Year	-37.12				
Unobligated Balance Available End of Year	45.68				
Recoveries of Prior Year Obligations	-0.05				
Adjustments to Prior Year Accounts	-				
Reductions Pursuant to P.L. 108-199, P.L. 109-148 and P.L. 108-272	1.40	2.47			
Appropriation Total	$175.05	$193.35	$240.45	$47.10	24.4%
SALARIES AND EXPENSES[1]	$223.45	$246.81	$281.82	$35.01	14.2%
Unobligated Balance Available Start of Year	-				
Unobligated Balance Available End of Year	-				
Adjustments to Prior Year Accounts	-				
Unobligated Balance Lapsing	-				
Reductions Pursuant to P.L. 108-199, P.L. 109-148 and P.L. 108-272	1.80	3.19			
Subtotal, S&E	$225.25	$250.00	$281.82	$31.82	12.7%
Transferred from other funds	-0.25				
Appropriation Total	$225.00	$250.00	$281.82	$31.82	12.7%
NATIONAL SCIENCE BOARD	$3.65	$3.95	$3.91	-$0.04	-1.0%
Unobligated Balanced Available Start of Year	-				
Unobligated Balanced Available End of Year	-				
Recoveries of Prior Year Obligations	-				
Adjustments to Prior Year Accounts	-				
Unobligated Balance Lapsing	0.32				
Reductions Pursuant to P.L. 108-199, P.L. 109-148 and P.L. 108-272	0.03	0.05			
Appropriation Total	$4.00	$4.00	$3.91	-$0.09	-2.3%
OFFICE OF INSPECTOR GENERAL	$10.17	$11.36	$11.86	$0.50	4.4%
Unobligated Balanced Available Start of Year	-1.22				
Unobligated Balanced Available End of Year	1.10				
Recoveries of Prior Year Obligations	-0.02				
Adjustments to Prior Year Accounts	-				
Unobligated Balance Lapsing	-				
Reductions Pursuant to P.L. 108-199, P.L. 109-148 and P.L. 108-272	0.08	0.14			
Appropriation Total	$10.11	$11.50	$11.86	$0.36	3.1%
TOTAL, NATIONAL SCIENCE FOUNDATION	$5,516.96	$5,653.37	$6,020.21	$366.84	6.5%

Totals may not add due to rounding.

[1] The FY 2005 Actual includes a transfer of $250,000 from the Department of State for processing an award to the U.S. Civilian Research and Development Foundation.

NSF FUNDING BY PROGRAM

(Dollars in Millions)

PROGRAM	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change Over FY 2006 Amount	Change Over FY 2006 Percent
BIOLOGICAL SCIENCES					
MOLECULAR AND CELLULAR BIOSCIENCES	$117.74	$108.27	$111.22	$2.95	2.7%
INTEGRATIVE ORGANISMAL BIOLOGY	103.12	100.39	100.74	0.35	0.3%
ENVIRONMENTAL BIOLOGY	106.47	106.71	109.61	2.90	2.7%
BIOLOGICAL INFRASTRUCTURE	81.41	81.80	85.90	4.10	5.0%
Research Resources	*49.98*	*51.03*	*35.58*	*-15.45*	*-30.3%*
Human Resources	*31.43*	*30.77*	*32.32*	*1.55*	*5.0%*
EMERGING FRONTIERS	73.80	80.80	99.16	18.36	22.7%
PLANT GENOME RESEARCH	94.24	98.72	101.22	2.50	2.5%
Total, BIO	$576.78	$576.69	$607.85	$31.16	5.4%
COMPUTER AND INFORMATION SCIENCE AND ENGINEERING					
COMPUTING & COMMUNICATION FOUNDATIONS	$91.29	$105.46	$122.82	$17.36	16.5%
COMPUTER & NETWORK SYSTEMS	132.17	141.53	162.98	21.45	15.2%
INFORMATION & INTELLIGENT SYSTEMS	92.31	103.62	119.30	15.68	15.1%
INFORMATION TECHNOLOGY RESEARCH	174.43	145.80	121.59	-24.21	-16.6%
Total, CISE	$490.20	$496.41	$526.69	$30.28	6.1%
ENGINEERING					
CHEMICAL, BIOENGINEERING AND ENVIRONMENTAL SYSTEMS	$112.06	$122.87	$124.44	$1.57	1.3%
CIVIL, MECHANICAL AND MANUFACTURING INNOVATION	141.13	146.79	152.16	5.37	3.7%
ELECTRICAL, COMMUNICATIONS AND CYBER SYSTEMS	70.79	77.27	80.90	3.63	4.7%
INDUSTRIAL INNOVATION AND PARTNERSHIPS	113.10	110.56	120.08	9.52	8.6%
ENGINEERING EDUCATION AND CENTERS	120.01	123.43	125.97	2.54	2.1%
EMERGING FRONTIERS IN RESEARCH AND INNOVATION	-	-	25.00	25.00	N/A
Total, ENG	$557.09	$580.92	$628.55	$47.63	8.2%

NSF FUNDING BY PROGRAM

(Dollars in Millions)

PROGRAM	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change Over FY 2006 Amount	Change Over FY 2006 Percent
GEOSCIENCES					
ATMOSPHERIC SCIENCES	$215.32	$216.09	$226.85	$10.76	5.0%
Atmospheric Sciences Research Support	*135.68*	*133.85*	*141.12*	*7.27*	*5.4%*
National Center for Atmospheric Research	*79.64*	*82.24*	*85.73*	*3.49*	*4.2%*
EARTH SCIENCES	136.95	140.12	152.30	12.18	8.7%
Earth Sciences Project Support	*103.67*	*106.46*	*115.90*	*9.44*	*8.9%*
Instrumentation and Facilities	*33.28*	*33.66*	*36.40*	*2.74*	*8.1%*
INNOVATIVE & COLLABORATIVE EDUCATION AND RESEARCH	*54.11*	*58.37*	*58.57*	0.20	0.3%
OCEAN SCIENCES	290.79	288.25	307.13	18.88	6.5%
Ocean Section	*99.72*	*107.58*	*114.62*	*7.04*	*6.5%*
Integrative Programs Section	*112.48*	*105.46*	*112.37*	*6.91*	*6.6%*
Marine Geosciences Section	*78.59*	*75.21*	*80.14*	*4.93*	*6.6%*
Total, GEO	$697.17	$702.83	$744.85	$42.02	6.0%
MATHEMATICAL AND PHYSICAL SCIENCES					
ASTRONOMICAL SCIENCES	$195.11	$199.65	$215.11	$15.46	7.7%
CHEMISTRY	179.26	180.78	191.10	10.32	5.7%
MATERIALS RESEARCH	240.09	242.91	257.45	14.54	6.0%
MATHEMATICAL SCIENCES	200.24	199.30	205.74	6.44	3.2%
PHYSICS	224.86	233.13	248.50	15.37	6.6%
MULTIDISCIPLINARY ACTIVITIES	29.80	29.68	32.40	2.72	9.2%
Total, MPS	$1,069.36	$1,085.45	$1,150.30	$64.85	6.0%
SOCIAL, BEHAVIORAL AND ECONOMIC SCIENCES					
SOCIAL AND ECONOMIC SCIENCES	$91.75	$93.15	$99.92	$6.77	7.3%
BEHAVIORAL AND COGNITIVE SCIENCES	79.13	79.77	84.13	4.36	5.5%
SCIENCE RESOURCES STATISTICS	25.92	26.99	29.71	2.72	10.1%
Total, SBE	$196.80	$199.91	$213.76	$13.85	6.9%

NSF FUNDING BY PROGRAM
(Dollars in Millions)

PROGRAM	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change Over FY 2006 Amount	Change Over FY 2006 Percent
OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING[1]	$43.38	$34.52	$40.61	$6.09	17.6%
OFFICE OF CYBERINFRASTRUCTURE	$123.40	$127.12	$182.42	$55.30	43.5%
UNITED STATES POLAR RESEARCH PROGRAMS	$278.27	$322.68	$370.58	$47.90	14.8%
UNITED STATES ANTARCTIC LOGISTICAL SUPPORT ACTIVITIES	$70.26	$66.66	$67.52	$0.86	1.3%
INTEGRATIVE ACTIVITIES	$130.92	$137.12	$131.37	-$5.75	-4.2%
ARCTIC RESEARCH COMMISSION	$1.19	$1.17	$1.45	$0.28	23.9%
Total, RESEARCH AND RELATED ACTIVITIES	$4,234.82	$4,331.48	$4,665.95	$334.47	7.7%
EDUCATION AND HUMAN RESOURCES					
RESEARCH ON LEARNING IN FORMAL AND INFORMAL SETTINGS	$238.76	$215.16	$215.00	-$0.16	-0.1%
EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR)	93.35	98.72	100.00	1.28	1.3%
UNDERGRADUATE EDUCATION	237.52	211.71	196.80	-14.91	-7.0%
Curriculum, Laboratory and Instructional Development	*94.48*	*88.13*	*86.50*	*-1.63*	*-1.8%*
Workforce Development	*63.98*	*60.40*	*64.30*	*3.90*	*6.5%*
Math and Science Partnership	*79.06*	*63.18*	*46.00*	*-17.18*	*-27.2%*
GRADUATE EDUCATION	154.75	153.02	160.57	7.55	4.9%
HUMAN RESOURCE DEVELOPMENT	119.16	118.08	143.85	25.77	21.8%
Undergraduate/Graduate Student Support	*70.83*	*70.51*	*82.85*	*12.34*	*17.5%*
Research & Education Infrastructure	*33.19*	*32.51*	*44.00*	*11.49*	*35.3%*
Opportunities for Women and Persons with Disabilities	*15.14*	*15.06*	*17.00*	*1.94*	*12.9%*
Total, EHR[2]	$843.54	$796.69	$816.22	$19.53	2.5%

[1] OISE FY 2005 Actual includes $9.42 million provided to NSF by the U.S. Department of State for an award to the U.S. Civilian Research and Development Foundation.
[2] Excludes $25.95 million in obligations in FY 2005 and an estimated $100.0 million in FY 2006 and FY 2007 from H-1B Nonimmigrant Petitioner Fees.

NSF FUNDING BY PROGRAM

(Dollars in Millions)

PROGRAM	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change Over FY 2006 Amount	Change Over FY 2006 Percent
MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION	$165.14	$190.88	$240.45	$49.57	26.0%
SALARIES AND EXPENSES[1]	$223.45	$246.81	$281.82	$35.01	14.2%
NATIONAL SCIENCE BOARD	$3.65	$3.95	$3.91	-$0.04	-1.0%
OFFICE OF INSPECTOR GENERAL	$10.17	$11.36	$11.86	$0.50	4.4%
NATIONAL SCIENCE FOUNDATION	$5,480.77	$5,581.17	$6,020.21	$439.04	7.9%

Totals may not add due to rounding.

[1] The FY 2005 Actual inlcudes a transfer of $250,000 from the U.S. Department of State for processing an award to the U.S. Civilian Research and Development Foundation.

OBJECT CLASSIFICATION
NSF Consolidated Obligations
(Dollars in Millions)

Object Class Code	Standard Title	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request
11.1	Full-time permanent	$111	$117	$126
11.3	Other than fulltime permanent	10	10	10
11.5	Other personnel compensation	6	6	6
11.8	Special personal service payment	1	2	2
	Total personnel compensation	128	135	144
12.1	Civilian personnel benefits	29	32	34
21.0	Travel and transportation of persons	17	21	21
23.1	Rental payments to GSA	19	22	24
23.3	Communications, utilities, and miscellaneous charges	2	2	2
25.1	Advisory and assistance services	64	75	77
25.2	Other services	20	12	12
25.3	Purchases of goods and services from Government accounts	12	16	16
25.4	Operation and maintenance of facilities	269	269	269
25.5	Research and development contracts	25	23	23
2.56	Medical Care	1	1	1
25.7	Operation and maintenance of equipment	22	22	38
26.0	Supplies and materials	4	4	4
31.0	Equipment	5	8	13
41.0	Grants, subsidies, and contributions	4,864	4,939	5,342
	Total, Direct obligations [1]	$5,481	$5,581	$6,020

Totals may not add due to rounding.

[1]Excludes obligations for the Donations and H-1B Nonimmigrant Petitioners accounts.

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.

Reimbursements by Agency
(Dollars in Millions)

DEPARTMENT/AGENCY	FY 2005 Actual
DEFENSE	
Air Force	$11.3
Army	$8.9
Other DOD (DARPA, NSA & Intelligence Agency)	$11.4
Navy	$2.7
Subtotal, DOD	$34.3
Army Corp of Engineers	$1.7
CIA	$5.7
Commerce (Other than NOAA)	$7.7
Education	$1.2
Energy	$10.8
GSA	$0.9
State	$0.5
Agriculture	$0.5
Health & Human Services	$21.8
Homeland Security	$4.9
Library of Congress	$2.0
NASA	$10.0
National Archives	$1.8
Housing and Urban Development	$1.6
OTHER (less than $500,000)	$1.5
TOTAL REIMBURSEMENTS	**$106.9**

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 2005 the largest portion of NSF's reimbursable activity came from joint activities with the Department of Defense (32.1 percent), the Department of Health and Human Services (20.4 percent), the Department of Energy (10.1 percent), and National Aeronautics and Space Administration (9.4 percent). Reimbursable activities with the Department of Defense were primarily for the management of the National Center for Atmospheric Research (NCAR). 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 Macromolecular Structure Database (MSD) program.

NSF Personnel Summary

	FY 2005 Actual
Full-Time Equivalent Employment (FTE)	1,279
Average GS Grade	11.04
Average GS Salary	$73,524
Average Salary[1]	$94,960

[1]Average based on all NSF permanent appointments.

Detail of Permanent Appointments

	FY 2005 Actual
ES-5	78
AD	315
GS/GM-15	77
GS/GM-14	98
GS/GM-13	107
GS-12	93
GS-11	57
GS-10	11
GS-9	78
GS-8	61
GS-7	110
GS-6	11
GS-5	3
GS-4	-
Subtotal	706
Total FTE, Permanent Appointments	1,099
Total FTE	1,279

EXPLANATION OF CARRYOVER FOR FY 2006 BY ACCOUNT

The National Science Foundation's total unobligated balance of $54.23 million from the FY 2005 Appropriations is described below.

- Within the **Research and Related Activities** (R&RA) appropriation $7.06 million was carried forward into FY 2006. This includes $3.98 million carried forward by the Engineering Directorate as part of a competition to award a Nanoscale Science and Engineering Center (NSEC). The Foundation is in the process of negotiating a complex potential cooperative agreement as a result of this competition. The remaining R&RA carryover includes $2.36 million carried forward for efforts relating to Hurricane Katrina and $720,804 carried forward for the Office of Polar Programs (OPP).

- Within the **Education and Human Resources** (EHR) appropriation $401,829 was carried forward into FY 2006. This includes $298,210 for efforts related to Hurricane Katrina and $100,000 for the Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring Program (PAESMEM).

- Within the **Major Research Equipment and Facilities Construction** (MREFC) appropriation $45.68 million was carried forward into FY 2006. OPP activities include $13.17 million for South Pole Station Modernization, $10.19 million for IceCube Neutrino Observatory (IceCube), and $33,795 for the South Pole Safety Project. The remaining MREFC carryover includes $12.94 million for GEO's Scientific Ocean Drilling Vessel (SODV), $5.79 million for GEO's EarthScope, $3.52 million for MPS' Atacama Large Millimeter Array (ALMA) Construction, and $33,819 for MPS' Large Hadron Collider. The amounts reported above include $14.88 million carried over for Rare Symmetry Violating Processes (RSVP) project that was distributed pro rata to the following projects: ALMA, $3.52 million; EarthScope, $3.62 million; IceCube, $3.60 million; and SODV, $4.14 million.

- Within the **Office of Inspector General** appropriation, a total of $1.09 million was carried forward into FY 2006 to fund priority audits that are contracted out; contracts for financial analysis and other technical support for OIG investigations, contract support for information technology and other administrative needs of the office, and personnel compensation costs. It may also be used to protect the appropriation against unanticipated variations between obligations and expenditures.

Distribution of FY 2005 Carryover into FY 2006

(Dollars in Millions)

	FY 2006 Current Plan	FY 2006 Carryover from FY 2005	Adjusted Total FY 2006 Estimate
Research and Related Activities	$4,331.48	$7.06	$4,338.54
Education and Human Resources[1]	796.69	0.40	797.09
Major Research Equipment and Facilities Construction	190.88	45.68	236.56
Salaries and Expenses	246.81	-	246.81
National Science Board	3.95	-	3.95
Office of Inspector General	11.36	1.09	12.45
Total	**$5,581.17**	**$54.23**	**$5,635.40**

Totals may not add due to rounding.

[1]Carryover excludes $89.58 million for H-1B Nonimmigrant Petitioner Receipts.

FULL BUDGETARY COSTING

The tables below show two methods for allocating the full budgetary cost of the NSF FY 2007 Budget 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: Ideas, Tools, and People. Organizational Excellence, NSF's fourth strategic goal encompasses the indirect costs to be allocated under full budgetary costing. These allocations represent part of the process, using readily available information, by which NSF achieved 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 through R&RA. The MREFC program funds are 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 direct S&E 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 direct S&E budget items that are 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 Award Management (BFA), the staff offices in the Office of the Director (OD), the NSB, and OIG are allocated. These indirect S&E budget items are allocated to a particular directorate based on its proportion of the total FY 2007 Request. The FY 2007 NSB and OIG budgetary costs are assigned using the same methodology as the Indirect S&E costs total. (Table 1)

Allocations by Strategic Outcome Goal

The full budgetary costing by Ideas, Tools, and People (ITP) 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 ITP percentages for each directorate. (Table 2)

FY 2007 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	OCI	OISE	OPP	IA	ARC	R&RA Total	EHR
FY 2007 OMB SUBMISSION	**$607,850**	**$526,690**	**$628,550**	**$744,850**	**$1,150,300**	**$213,760**	**$182,420**	**$40,610**	**$438,100**	**$131,370**	**$1,450**	**$4,665,950**	**$816,220**
MREFC													
AdvLIGO												-	
ALMA Construction					47,890							**$47,890**	
ARRV				56,000								**$56,000**	
DOJ Judgment									3,000			**$3,000**	
EarthScope				27,400								**$27,400**	
HIAPER												-	
IceCube Neutrino Observatory									28,650			**$28,650**	
LC-130 DOJ Judgement												-	
NEES												-	
NEON	12,000											**$12,000**	
OOI				13,500								**$13,500**	
RSVP												-	
Scientific Ocean Drilling				42,880								**$42,880**	
South Pole Station Modernization									9,130			**$9,130**	
Terascale Computing Systems												-	
MREFC Subtotals	**$12,000**	**-**	**-**	**$139,780**	**$47,890**	**-**	**-**	**-**	**$40,780**	**-**	**-**	**$240,450**	**-**
Total Directorate FY 2007 Submission including MREFC	**$619,850**	**$526,690**	**$628,550**	**$884,630**	**$1,198,190**	**$213,760**	**$182,420**	**$40,610**	**$478,880**	**$131,370**	**$1,450**	**$4,906,400**	**$816,220**
Direct S&E													
Space Rental	3,105	1,835	3,274	2,851	3,528	2,907	310	1,016	1,355			$20,181	$3,698
PC&B	22,296	13,175	23,512	20,472	25,336	20,877	2,230	7,297	9,729			$144,924	$26,553
Distributed S&E	1,495	884	1,577	1,373	1,699	1,400	150	489	652			$9,719	$1,781
Direct S&E Subtotals	**$26,896**	**$15,894**	**$28,363**	**$24,696**	**$30,563**	**$25,184**	**$2,690**	**$8,802**	**$11,736**			**$174,824**	**$32,032**
Indirect S&E Cost Allocation	9,747	5,760	10,279	8,950	11,076	9,127	975	3,190	4,253			$63,357	$11,606
Direct & Indirect S&E Subtotals	**$36,643**	**$21,654**	**$38,642**	**$33,646**	**$41,639**	**$34,311**	**$3,665**	**$11,992**	**$15,989**			**$238,181**	**$43,638**
NSB Allocation	**$508**	**$300**	**$536**	**$467**	**$578**	**$476**	**$51**	**$166**	**$222**			**$3,304**	**$605**
OIG Allocation	**$1,542**	**$911**	**$1,626**	**$1,416**	**$1,752**	**$1,444**	**$154**	**$505**	**$673**			**$10,023**	**$1,836**
NSF TOTAL	**$658,543**	**$549,555**	**$669,354**	**$920,159**	**$1,242,159**	**$249,991**	**$186,290**	**$53,273**	**$495,764**	**$131,370**	**$1,450**	**$5,157,908**	**$862,299**

FY 2007 FULL BUDGETARY COSTING

Table 2: Allocation by Ideas, Tools and People

(Dollars in Thousands)

Total Directorate FY 2007	BIO	CISE	ENG	GEO	MPS	SBE	OCI	OISE	OPP	IA	ARC	R&RA	EHR
Ideas	440,828	437,899	538,924	407,113	759,775	184,124	4,307	40,741	91,665	27,900	1,450	2,934,726	177,311
Tools	146,511	32,797	33,082	471,853	353,867	52,746	170,126		392,906	94,280		1,748,168	16,600
People	71,204	78,859	97,348	41,193	128,517	13,121	11,857	12,532	11,193	9,190		475,014	668,388
FULL BUDGETARY COST	**$658,543**	**$549,555**	**$669,354**	**$920,159**	**$1,242,159**	**$249,991**	**$186,290**	**$53,273**	**$495,764**	**$131,370**	**$1,450**	**$5,157,908**	**$862,299**

Totals may not add due to rounding.

CHANGES BETWEEN FY 2006 REQUEST AND FY 2006 CURRENT PLAN

The FY 2006 Current Plan for the National Science Foundation is $5,581.17 million, or .43 percent less than requested. This represents an increase of $100.4 million above the FY 2005 Actual of $5,480.77 million. Funding levels for the FY 2006 Current Plan include two rescissions totaling 1.28 percent.

Changes Between FY 2006 Request and FY 2006 Current Plan

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Request	FY 2006 Current Plan	Change between FY 2006 Request and FY 2006 Current Plan Amount	Percent
Research and Related Activities	$4,234.82	$4,333.49	$4,331.48	-$2.01	-0.0%
Education and Human Resources	843.54	737.00	796.69	59.69	8.1%
Major Research Equipment	165.14	250.01	190.88	-59.13	-23.7%
Salaries and Expenses	223.45	269.00	246.81	-22.19	-8.2%
National Science Board	3.65	4.00	3.95	-0.05	-1.3%
Office of Inspector General	10.17	11.50	11.36	-0.14	-1.2%
Total, NSF	$5,480.77	$5,605.00	$5,581.17	-$23.83	-0.4%

Totals may not add due to rounding.

The FY 2006 Current Plan for the **Research and Related Activities** (R&RA) Account is $4,331.48 million, a decrease of $2.01 million, or less than one percent, from the FY 2006 Request. Funding for all activities, subactivities, and programs closely aligns with the FY 2006 Request. Here are some highlights:

The Plan for the Directorate for Biological Sciences includes $98.72 million for plant genome research.

The Plan for the Directorate for Mathematical and Physical Sciences provides $50.74 million for the National Radio Astronomy Observatories, almost $5.0 million for Elementary Particle Physics research programs, and $141.54 million for the National Nanotechnology Initiative.

The Plan for the Directorate for Social, Behavioral and Economic Sciences (SBE) provides continued support for the Children's Research Initiative and almost $2.60 million for Science Metrics.

Of funds provided for Integrative Activities, $88.39 million will support Major Research Instrumentation.

The Directorate for **Education and Human Resources** (EHR) is funded at $796.69 million, an increase of $59.69 million, or 8.1 percent, over the FY 2006 Request. Support for all subactivities and programs closely follows the FY 2006 Request. Increased funding is chiefly focused on the Experimental Program to Stimulate Competitive Research (EPSCoR), Research and Evaluation on Education in Science and Engineering (REESE), and formal K-12 education programs, especially those that broaden participation.

The **Major Research Equipment and Facilities Construction** (MREFC) Account is funded at $190.88 million, a decrease of $59.13 million, or 23.7 percent, from the FY 2006 Request. Of this, $45.14 million provides for the Atacama Large Millimeter Array (ALMA) radio telescope, $46.40 million for the EarthScope, $46.25 million for the IceCube Neutrino Detection project, and $53.09 million for the

Scientific Ocean Drilling Vessel. The decrease reflects $41.78 million requested for the cancelled RSVP project in the FY 2006 Request and the unobligated balance of $14.88 million originally appropriated for RSVP in FY 2005. This unobligated amount was distributed pro rata to the four ongoing projects.

The **Salaries and Expenses** (S&E) Account totals $246.81 million, a reduction of over $22.0 million from the FY 2006 Request. Certain proposed infrastructure investments will continue to be postponed as available resources will be used to fund staffing increases. S&E 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) is funded at $3.95 million.

The **Office of Inspector General** (OIG) is funded at $11.36 million.

NATIONAL SCIENCE FOUNDATION

Research and Development Special Analysis

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request
Support of R&D		(Dollars in Thousands)	
Conduct of Research and Development			
Basic Research	$3,410,676	$3,462,404	$3,670,582
Applied Research	332,188	319,471	378,835
Subtotal, Conduct of R&D	3,742,864	3,781,875	4,049,417
R&D Facilities			
Land, Building and Fixed Equipment	13,811	12,700	14,540
Major Equipment	341,671	380,071	458,570
Subtotal, R&D Facilities & Major Equipment	355,482	392,771	473,110
Total, Support of R&D	4,098,346	4,174,646	4,522,527
Non-Investment Activities	558,667	609,190	677,034
Education and Training	823,760	797,334	820,651
TOTAL	$5,480,773	$5,581,170	$6,020,212

Totals may not add due to rounding.

RESEARCH AND RELATED ACTIVITIES

Research and Development Special Analysis

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request
Support of R&D		(Dollars in Thousands)	
Conduct of Research and Development			
Basic Research	$3,282,801	$3,342,404	$3,547,582
Applied Research	311,303	300,471	358,835
Subtotal, Conduct of R&D	3,594,104	3,642,875	3,906,417
R&D Facilities			
Land, Building and Fixed Equipment	13,811	12,700	14,540
Major Equipment	175,269	188,191	217,120
Subtotal, R&D Facilities & Major Equipment	189,080	200,891	231,660
Total, Support of R&D	3,783,184	3,843,766	4,138,077
Non-Investment Activities	300,966	328,070	359,442
Education and Training	150,674	159,644	168,431
TOTAL	$4,234,824	$4,331,480	$4,665,950

Totals may not add due to rounding.

EDUCATION AND HUMAN RESOURCES

Research and Development Special Analysis

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request
Support of R&D		(Dollars in Thousands)	
Conduct of Research and Development			
Basic Research	$127,875	$120,000	$123,000
Applied Research	20,885	19,000	20,000
Subtotal, Conduct of R&D	148,760	139,000	143,000
R&D Facilities			
Land, Building and Fixed Equipment	-	-	-
Major Equipment	1,262	1,000	1,000
Subtotal, R&D Facilities & Major Equipment	1,262	1,000	1,000
Total, Support of R&D	150,022	140,000	144,000
Non-Investment Activities	20,437	19,000	20,000
Education and Training	673,086	637,690	652,220
TOTAL	$843,545	$796,690	$816,220

Totals may not add due to rounding.

MAJOR RESEARCH EQUIPMENT FACILITIES CONSTRUCTION

Research and Development Special Analysis

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request
Support of R&D		(Dollars in Thousands)	
Conduct of Research and Development			
Basic Research	-	-	-
Applied Research	-	-	-
Subtotal, Conduct of R&D	-	-	-
R&D Facilities			
Land, Building and Fixed Equipment	-	-	-
Major Equipment	$165,140	$190,880	$240,450
Subtotal, R&D Facilities & Major Equipment	165,140	190,880	240,450
Total, Support of R&D	165,140	190,880	240,450
Non-Investment Activities	-	-	-
Education and Training	-	-	-
TOTAL	$165,140	$190,880	$240,450

Totals may not add due to rounding.

SALARIES AND EXPENSES

Research and Development Special Analysis

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request
Support of R&D		(Dollars in Thousands)	
Conduct of Research and Development			
Basic Research	-	-	-
Applied Research	-	-	-
Subtotal, Conduct of R&D	-	-	-
R&D Facilities			
Land, Building and Fixed Equipment	-	-	-
Major Equipment	-	-	-
Subtotal, R&D Facilities & Major Equipment	-	-	-
Total, Support of R&D	-	-	-
Non-Investment Activities	$223,449	$246,810	$281,822
Education and Training	-	-	-
TOTAL	$223,449	$246,810	$281,822

Totals may not add due to rounding.

NATIONAL SCIENCE BOARD

Research and Development Special Analysis

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request
Support of R&D		(Dollars in Thousands)	
Conduct of Research and Development			
Basic Research	-	-	-
Applied Research	-	-	-
Subtotal, Conduct of R&D	-	-	-
R&D Facilities			
Land, Building and Fixed Equipment	-	-	-
Major Equipment	-	-	-
Subtotal, R&D Facilities & Major Equipment	-	-	-
Total, Support of R&D	-	-	-
Non-Investment Activities	$3,650	$3,950	$3,910
Education and Training	-	-	-
TOTAL	$3,650	$3,950	$3,910

Totals may not add due to rounding.

OFFICE OF INSPECTOR GENERAL

Research and Development Special Analysis

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request
Support of R&D		(Dollars in Thousands)	
Conduct of Research and Development			
Basic Research	-	-	-
Applied Research	-	-	-
Subtotal, Conduct of R&D	-	-	-
R&D Facilities			
Land, Building and Fixed Equipment	-	-	-
Major Equipment	-	-	-
Subtotal, R&D Facilities & Major Equipment	-	-	-
Total, Support of R&D	-	-	-
Non-Investment Activities	$10,165	$11,360	$11,860
Education and Training	-	-	-
TOTAL	$10,165	$11,360	$11,860

Totals may not add due to rounding.