NATIONAL SCIENCE FOUNDATION

FY 2008 Budget Request to Congress

February 5, 2007

On the cover: ***North Pole Midnight Sun.*** The sun skirts the horizon at the top of the world. In early springtime, the sun at the North Pole is on its way to its highest point in the sky, the period when it will not set for several weeks.

Cover image courtesy of Peter West, National Science Foundation

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FY 2008 BUDGET REQUEST TO CONGRESS

Budget Request

The National Science Foundation proposes a FY 2008 investment of $6.43 billion to advance the frontiers of research and education in science and engineering. The NSF FY 2008 Budget Request includes an increase of $408.79 million (6.8 percent) over the FY 2007 Budget Request. At this level, NSF will build on recent advances and support promising initiatives to strengthen the Nation's capacity for discovery and innovation.

The President's American Competitiveness Initiative (ACI) sets a bold challenge, calling for expanded federal investment to drive innovation and sharpen the Nation's competitive edge. To maintain the U.S. position at the forefront of discovery, learning, and innovation, the American Competitiveness Initiative commits to doubling investments over 10 years in NSF and other principal sources of federal support for the physical sciences and engineering. NSF's task in this ambitious undertaking is to uphold the leadership and excellence in fundamental research and education that keeps America at the leading edge of science, engineering, and technology.

To meet the challenges posed by the ACI, the new NSF Strategic Plan for FY 2006 to FY 2011 underscores the Foundation's role as a focal point in the Nation's innovation enterprise. The plan charts an ambitious course for the future, stressing investment opportunities that promise to stimulate innovation, contribute to economic growth, and provide exceptional returns on America's investment in frontier research and education.

The four strategic outcome goals established in the plan shape the overall investment strategy for this Request:

- Discovery – Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the Nation as a global leader in fundamental and transformational science and engineering.

- Learning – Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.

- Research Infrastructure – Build the Nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure, and experimental tools.

- Stewardship – Support excellence in science and engineering research and education through a capable and responsive organization.

To implement these strategies in FY 2008, this Request addresses five priorities:

- Discovery Research for Innovation
- Preparing the Workforce of the 21st Century

- Transformational Facilities & Infrastructure
- International Polar Year Leadership
- Stewardship

Each priority targets investments in concrete scientific, engineering, and educational challenges of major significance to the Nation and the world. Rapid progress in these areas will generate new concepts and tools with far-reaching applications, lay the foundations for next-generation tools and technologies, and develop educational strategies to engage students and prepare them to excel in a fast-changing, global environment. The Request also reflects the Foundation's continued commitment to efficient and effective management of public resources.

NSF Funding by Account
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Research and Related Activities[1/]	$4,449.25	$4,765.95	$5,131.69	$365.74	7.7%
Education and Human Resources	700.26	716.22	750.60	34.38	4.8%
Major Research Equipment and Facilities Construction	233.81	240.45	244.74	4.29	1.8%
Agency Operations and Award Management	247.06	281.82	285.59	3.77	1.3%
National Science Board	3.94	3.91	4.03	0.12	3.1%
Office of Inspector General	11.47	11.86	12.35	0.49	4.1%
Total, NSF	$5,645.79	$6,020.21	$6,429.00	$408.79	6.8%

Totals may not add due to rounding.

[1/] In FY 2008, funding for EPSCoR is requested within the Research and Related Activities appropriation. Prior to FY 2008, EPSCoR was funded within the Education and Human Resources appropriation. EPSCoR is included here in Research and Related Activities for all years for comparability.

Why Frontier Research Matters

America faces new challenges in this era of global transformation and integration. Discovery and innovation – the forces driving U.S. economic growth and providing a steady stream of benefits to society – now take place in a dynamic, complex, and competitive international environment. Other nations are emulating the strategies that have sustained U.S. leadership in science, engineering, and education. Many nations are investing in frontier research and developing well-honed talent, fueling the lightning-quick pace of discovery and innovation worldwide, and driving fierce competition for knowledge and talent.

> *"America's economic strength and global leadership depend in large measure on our Nation's ability to generate and harness the latest in scientific and technological developments and to apply these developments to real world applications."*
>
> – American Competitiveness Initiative

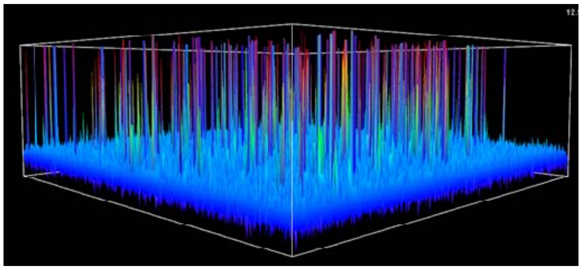
At the same time, opportunities to make significant progress in meeting pressing national needs – in energy, health, security, and environment – and resolve longstanding dilemmas of global scope are now more plentiful than ever before. Thanks to past federal investments in research and education, the Nation is well-equipped to tackle the most complex and challenging questions of our times. The result is that we stand poised on the threshold of a new era of exceptional scientific and technological promise.

As a leader in the global science and engineering enterprise, America has always been a valued partner in the global arena – maintaining excellence in research and education at home and attracting talent and investment from abroad. Changing global circumstances demand that we take vigorous steps to demonstrate our continued leadership, and to ensure that Americans reap not only the benefits we enjoy today, but also the revolutionary technologies of tomorrow that will lift the Nation and the world.

Research that Benefits the Nation

The ingenuity of America's researchers – and the relentless quest of business and industry for new concepts – puts American innovation to work rapidly, for the benefit of society and the economy. Today, valuable knowledge and marketable technologies are emerging at breathtaking speed. Just this past year, researchers funded by NSF reported significant results and launched new initiatives that will keep benefits flowing to the American people. Examples include:

► **Nanotechnology Powered by Your Body:** Medical devices implanted in the human body are normally battery operated. But a promising new approach may enable humans to tap into the body's own energy via a "nanogenerator." Developed by NSF-funded researchers at the Georgia Institute of Technology, nanogenerators convert mechanical energy into electrical energy from body movement, muscle stretching, or water flow into electrical energy. This technique could open up tremendous possibilities for self-powered, implantable biomedical devices, as well as wireless sensors, portable electronics, and other applications. The nanogenerators produce electricity by bending and then releasing zinc oxide nanowires. By creating interconnected groups of arrays containing millions of wires, researchers can potentially produce enough current to power nanoscale devices, eliminating the need for bulky power sources.



Output voltage (vertical scale) of a nano-wire array. Researchers are using nano-wire arrays to create nanogenerators to power implantable medical devices. *Credit: Z.L. Wang, Georgia Tech.*

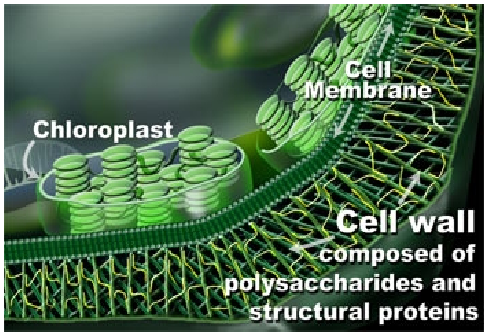
► **Research Adds to Economic Growth:** New calculations from the U.S. Bureau of Economic Analysis suggest research and development (R&D) accounted for a substantial share of the resurgence in U.S. economic growth in recent years. Using data from the NSF's annual surveys of government, academic, industry, and non-profit R&D expenditures, the bureau determined that R&D contributed 6.5 percent to economic growth between 1995 and 2002. NSF and agencies in many other nations collect extensive R&D expenditure data because R&D is vital to economic growth and social welfare and often results in unimagined benefits. The resources that organizations devote to R&D influence both economic growth and international competitiveness.

The Bureau of Economic Analysis used NSF data to determine the impact of research and development on the economy. Research and development contributed 6.5 percent to U.S. economic growth between 1995 and 2002.

► **Untangling Traffic with Cell Phones:** Engineers have developed a system that takes anonymous cell-phone location information and turns it into an illuminated traffic map that identifies congestion in real time. The system takes advantage of the steady stream of positioning cues, untraced signals all cell phones produce whether in use or not, as they seek towers. It is the first traffic-solution technology that monitors patterns on rural roads and city streets as easily as on highways. Developed by IntelliOne of Atlanta, Ga., with a Small Business Innovation Research grant from NSF, the TrafficAid system could not only help guide drivers around tie-ups, but also tell emergency responders where accidents are or how effectively an evacuation is unfolding by pinpointing clusters of cell phones. Unlike sensors and other equipment along major freeways that are expensive and take years to deploy, this system takes advantage of existing cellular networks in which wireless carriers have already invested billions of dollars, according to NSF awardee and IntelliOne CEO Ron Herman.

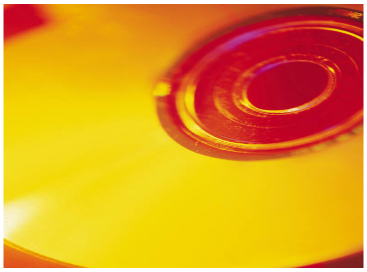
The IntelliOne Roadway Speed Measurement System uses cell phone signals to map roadway speeds for all highways and surface streets where mobile phone coverage exists. The blue dots represent a snapshot of all active mobile phones from a single carrier's network in Tampa, Fla. *Credit: IntelliOne Technologies Corporation.*

► **How Does Your Garden Grow?:** In a finding that could make it cheaper and easier to convert plant fibers into ethanol bio-fuels and other products, scientists have taken another step toward understanding how plants synthesize the fibrous carbohydrates that make up their cell walls. Cell-wall carbohydrates constitute a major source of dietary fiber and have numerous commercial applications. However, identifying the molecular machinery that plants use to make these critical components of their cell walls has been a major challenge – until now. With support from NSF's Plant Genome Research Program, Michigan State University scientists were able to study plant proteins in a background free of other competing plant enzymes and to identify genes critical to the production of cell wall carbohydrates. This insight brings scientists closer to developing plants that provide increased nutrition, cheaper food additives, and improved digestibility.

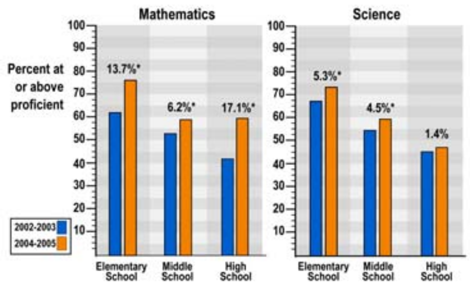


Researchers have recently identified plant genes responsible for the production of cell-wall carbohydrates. Cell walls are the protective sheaths that give plant cells shape and protect them from disease and dehydration. *Credit: Nicolle Rager Fuller, NSF.*

► **Biodegradable Plastics from Carbon Dioxide:** NSF-funded researchers from Texas A&M University have pioneered a method to accelerate the conversion of carbon dioxide (CO_2) gas into the biodegradable thermoplastics used in eyeglass lenses, shatterproof glass, baby bottles, CDs, and DVDs. Current methods for making thermoplastics generally require petroleum. However, researchers have pioneered a method to produce biodegradable plastic products using atmospheric CO_2 – a productive use for the greenhouse gas. Researchers are now working to develop effective non-toxic metal catalysts for producing another extremely useful plastic, polycarbonate, from CO_2 and other compounds. This plastic can be made into biodegradable rubber-like substances that have potential biomedical applications, such as surgical sutures, drug delivery devices, and body or dental implants.

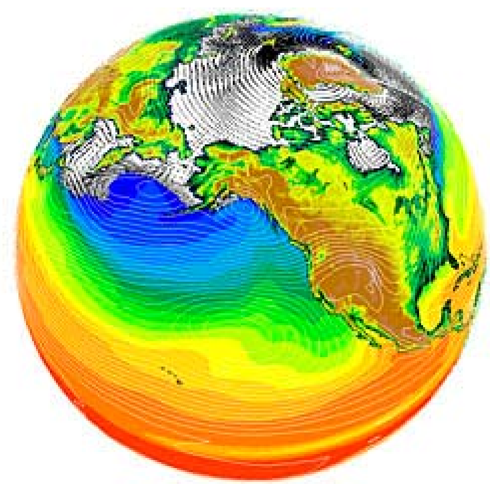


Researchers have pioneered a method to speed the up production of biodegradable plastic products manufactured using atmospheric CO_2, providing a productive use for the greenhouse gas. *Credit: Paul Spyropoulos, NSF.*



► **Math and Science Partnership Students Leap Ahead:** Elementary, middle- and high-school students participating in the NSF Math and Science Partnership (MSP) program continued to show improvement in mathematics and science proficiency over the three year time period from 2002-2003 to 2004-2005, according to an analysis of data gathered by NSF-funded researchers. Elementary students achieved the most dramatic increases in mathematics, where 7.2 percent more students achieved or exceeded proficiency from 2002-03 to 2003-04, followed by an increase of another 6.5 percent from 2003-04 to 2004-05. Students at all levels showed significant improvements in mathematics proficiency for the three-year period. Scores in science also showed gains from the first to third years at all grade spans. Over the three-year period, the MSP Program provided professional development opportunities to 30,000 K-12 teachers in 550 school districts nationwide. Projects in the current MSP portfolio are expected to impact more than 141,000 science and mathematics teachers and 4.2 million students over 550 local school districts.

► **Expanding the Computational Grid Frontier:** The Globus Toolkit – an open-source library of gridding middleware and software used to integrate geographically distributed computing systems – is the de facto standard for building grids, and Globus development is in part supported by NSF. IBM promotes Globus as its standard open source grid platform. Several prominent companies also rely on Globus-related applications, e.g., Intel for internal grids and Cisco for network management. The National Cancer Institute's $100-million Globus-based Cancer Bioinformatics Grid program engages companies at multiple levels. Globus' indirect impacts are also significant. Virtually every major computer vendor has a "grid product," and most of the Fortune 500 have a "grid strategy." All are influenced by the work on Globus even if they do not use Globus software directly.



Scientists in the Earth System Grid – who use Globus software for security, data movement, and system monitoring – are providing access to climate data. This image shows sea ice extent (white/gray), sea ice motion, sea surface temperatures (colors), and atmospheric sea level pressure (contours). *Credit: UCAR.*

Credit: Photos.com

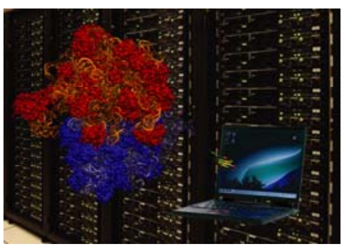
► **Using the Sun to Heat and Cool:** Researchers are developing a thin-film technology that adheres both solar cells and heat pumps onto surfaces, ultimately turning walls and windows into climate control systems -- and harvesting the sun's energy to both heat and cool. NSF-funded researchers at Rensselaer Polytechnic Institute have built a prototype Active Building Envelope system. Made of solar panels, thermo-electric heat pumps, and a storage device to provide energy on rainy days, the system silently cools and heats with no moving parts.

Investment Priorities

Discovery Research for Innovation

NSF works at the frontiers of knowledge where new ideas are born, nurtured, and in time bear fruit in economic and social returns. High-risk, high-reward research at the frontier can lay the foundation for revolutionary technologies, tackle extremely difficult challenges of enormous social and economic significance, and expand the transformational power of science, engineering, and education. To address priorities identified in the ACI and to promote research that will drive innovation, NSF will target programs in cyberinfrastructure, engineering, mathematics, and the computing and physical sciences, as well as programs that promise to have a substantial impact on quality of life. Some highlights of these investments follow.

Cyber-enabled Discovery and Innovation (CDI) $52 million



This Request includes an important new NSF-wide investment to broaden the Nation's capability for innovation by developing a new generation of computationally based discovery concepts and tools to deal with complex, data-rich, and interacting systems. The rapidly emerging world of peta-scale computers, massive data flows, and databases pose exceptional challenges that require capabilities well beyond those available today. Cyber-enabled Discovery and Innovation aims to explore radically new concepts, approaches, and tools at the intersection of computational and physical or biological worlds to address such challenges. New means of computational discovery will augment the traditional discovery-innovation loop with novel computational concepts to aid knowledge discovery, analysis, and experimentation. This will accelerate the discovery of knowledge buried in massive datasets, creation of models to understand complex phenomenon, and understanding of rare events. CDI includes five distinct themes: knowledge extraction, interacting elements, computational experimentation, virtual environments, and education for computational discovery.

National Nanotechnology Initiative $390 million

NSF is increasing its investment in the interagency National Nanotechnology Initiative by nearly $17 million in FY 2008. Increased funding amounts are requested for fundamental nanoscale research, development of nanomaterials, and for research directed at environmental, health, and safety impacts of nanotechnology development. This includes a new multidisciplinary focus on fundamental research on the environmental, health, and safety impacts of nanomaterials. This research will explore the interactions between particles and materials at the nanoscale and the living world with development of innovative methods of investigation and instrumentation an essential focus.

Ocean Research Priorities Plan **$17 million**

Understanding the interactions between society and the ocean is of vital importance for ensuring a clean, healthy, and stable ocean environment. The Ocean Research Priorities Plan (ORPP), developed by the Joint Subcommittee on Ocean Science and Technology of the National Science and Technology Council (NSTC), identifies significant research challenges needed to understand ocean dynamics, forecast ocean events, and manage ocean resources. This new investment of $17 million in FY 2008 will support research in four areas identified in the Plan as critical near-term priorities: the complex dynamics that control and regulate marine ecosystem processes; the variability of the Atlantic Meridional Overturning Circulation; the response of coastal ecosystems to extreme and abrupt events; and the development of new sensors to improve ocean observations. Research in these areas will provide the scientific foundation to improve society's stewardship and use of the ocean and ocean resources.

Cybersecurity Research and Development **$107 million**

Networked computers reside at the heart of systems on which people now rely, both in critical national infrastructures and in homes, cars, and offices. Today, many of these systems are far too vulnerable to cyber attacks. With a focus on activities that address threats to the Nation's critical infrastructure, NSF will increase its investment in cybersecurity research in FY 2008 by $10 million, In addition, the NSF Cyber Trust program will support research to make networked computer systems more predictable, more accountable, and less vulnerable to attack and abuse. Cyber Trust also includes educational programs to ensure that networked computer systems 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.

EPSCoR **$107 million**

NSF will increase support by $7 million for the Experimental Program to Stimulate Competitive Research (EPSCoR). EPSCoR investments provide strategic programs and opportunities for participants – jurisdictions and states that have historically received less federal R&D funding – to make sustainable improvements in research capacity and national research competitiveness. The EPSCoR program strengthens knowledge-based prosperity for participants and also contributes substantially to the Nation's overall ability to compete globally. Beginning in FY 2008, funding for the NSF EPSCoR program will be included in the Research and Related Activities account.

International Science and Engineering **$45 million**

NSF will continue to support the participation of U.S. scientists and engineers in international programs that are innovative and responsive to a broad range of NSF and national interests. The locus for these investments is the Office of International Science and Engineering, which increases nearly 11 percent in FY 2008 to a total of $45 million. These include opportunities for U.S. undergraduate and graduate students to engage in international activities, an increasingly important part of a student's training in this era of globalization. International partnerships, now an abiding feature of the global science and engineering enterprise, provide U.S. scientists and engineers with the opportunity to keep up-to-date on new concepts and technologies emerging around the world, and provide the experience needed to operate effectively in teams comprised of partners from different nations and cultural backgrounds.

Preparing the Workforce of the 21st Century

Creating a strong science and engineering workforce for the future is vital to maintaining the Nation's competitive edge. NSF will continue to fund a broad spectrum of successful programs that contribute to this goal. CAREER is an NSF-wide program that supports outstanding junior faculty in all disciplines supported by the Foundation, and is often a vital link to establishing a successful academic research record. Efforts to train an efficient, effective, and agile IT workforce are also central in a number of NSF programs, such as Broadening Participation in Computing and Advanced Technological Education. In addition, NSF provides support for development of a world-class teaching corps through programs such as the Noyce Scholarship program. Other programs – including the STEM Talent Expansion Program (STEP) and the Centers for Research Excellence in Science and Technology (CREST) program – will strengthen efforts to promote innovation and develop a strong science and engineering workforce by broadening participation of underrepresented groups and types of institutions, two objectives of vital importance to maintaining America's global competitiveness.

NSF educational support will be closely coordinated with other agencies, consistent with the Academic Competitiveness Council (ACC). Working with the Department of Education and other agencies active in STEM education, NSF will continue to develop and apply rigorous evaluation criteria to our portfolio of education programs in order to ensure U.S. students receive the highest quality STEM education.

In coordination with the Department of Education, NSF will continue funding for the Math and Science Partnership program, aimed at improving K-12 science and math education and teaching. The budget request also includes funding for an additional 200 Graduate Research Fellowships (GRF), bringing the total number of GRFs supported to about 2,950.

Transformational Facilities and Infrastructure

NSF supports the conceptualization, design, and development of innovative facilities and instruments that provide vital momentum to advance the frontiers of discovery, including large-scale, broadly accessible facilities, mid-scale instruments, and cyberinfrastructure.

- For FY 2008, NSF proposes one new start in the Major Research Equipment and Facilities Construction account (MREFC): Advanced LIGO (AdvLIGO), a gravitational wave observatory that will improve by a factor of 10 the sensitivity of current earth-based facilities.
- In addition, NSF will raise the maximum level of funding within the Major Research Instrumentation (MRI) program from $2.0 million to $4.0 million to provide for the acquisition and development of mid-size instruments, such as e-beam lithography and nanofabrication tools, large-scale petawatt lasers, and spectroscopy instruments. Funding for the MRI program increases by $24.44 million in FY 2008, to a total of $114.44 million.
- NSF will continue support for the development of a petascale computing capability widely accessible to the science and engineering community. The development of cyberinfrastructure, which significantly augments computational and networking capabilities available to scientists and engineers in all disciplines, will remain a significant focus of NSF investment.

International Polar Year Leadership

Credit: Shawn Marshall

As the lead agency supporting Polar research, NSF will provide U.S. leadership for International Polar Year (IPY) activities through support for an intense research and public education effort among grantees, in coordination with other agencies, and in cooperation with other nations. NSF's Request for supporting these activities is nearly $59 million for FY 2008. A major focus for NSF IPY activities will be climate change research and environmental observations. Much of the research supported under IPY will support the goals of the U.S. Climate Change Science Program. Work will include observations, data analysis, models, and basic and social science research to strengthen our ability to understand and respond to global environmental issues. In most instances, U.S. scientists' efforts will be leveraged by the related efforts of international scientists. Another major focus will be research that explores how life adapts to and survives in the polar dark, with emphasis on the cellular and genomic levels but reaching to human impacts as well. A third focus of IPY will be maintaining existing standardized data sets, creating new scientific collections, and ensuring their availability to current and future generations of researchers. IPY offers a fine opportunity for outreach and education to raise public understanding of science and engineering, and NSF will continue to support such efforts.

Stewardship

NSF's FY 2006 - FY 2011 Strategic Plan defines the Stewardship strategic goal as the support of "excellence in science and engineering research and education through a capable and responsive organization." As a direct result of the strategic planning process, NSF has established eight new multi-year stewardship objectives, including strengthening our traditional partnerships and developing new collaborations with other agencies and organizations, expanding efforts to broaden participation from underrepresented groups and institutions in all NSF activities, and improving the transparency, consistency, and uniformity of the merit review process. A major objective in FY 2008 is establishing the Research.gov portal site, which will provide an updated suite of services aimed at the grantee community and share grants management solutions among research agencies as part of the Grants Management Line of Business.

NSF proposes to change the name of the *Salaries and Expenses* account to *Agency Operations and Award Management*. The proposed name is a straightforward description that reflects both the content of the activity and its overall purpose.

Interagency R&D Priorities

NSF plays a significant role in several interagency R&D priorities including the Networking and Information Technology R&D (NITRD) program, the National Nanotechnology Initiative (NNI), the U.S. Climate Change Science Program (CCSP) and Homeland Security.

INTERAGENCY R&D PRIORITIES
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
National Nanotechnology Initiative	$359.71	$373.18	$389.90	$16.72	4.5%
Climate Change Science Program	196.88	205.25	208.25	3.00	1.5%
Networking and Information Technology R&D	811.53	903.74	993.69	89.95	10.0%
Homeland Security	342.10	385.91	375.36	-10.55	-2.7%

The Foundation will continue as a major participant in each of these areas in FY 2008, with increases for NNI, NITRD, and CCSP. The change for Homeland Security funding reflects the fact that FY 2007 included a one-time investment of $20 million for research relevant to the detection of explosives and related threats. Additional information on NITRD, NNI, and CCSP can be found in the NSF-wide Investments section. For Homeland Security, additional information is available in the Summary Tables and Charts section.

Delivering Results

NSF's FY 2008 Budget Request incorporates the Research and Development Investment Criteria outlined in the President's Management Agenda. The three sections below describe NSF's approach to ensuring that its investments address Relevance, Quality, and Performance. More specific information on the criteria is integrated throughout this document in discussions of investments by each of NSF's directorates and major program offices.

The nature of NSF's programming gives the agency an invaluable level of flexibility and agility. NSF has proven time and again that it can respond decisively and proactively to emerging opportunities and challenges. These qualities are especially valuable in maintaining a dynamic and productive portfolio in the current funding environment. With only five to six percent of the agency's budget spent on internal operations – the remaining supports other organizations working at the frontiers of learning and discovery – NSF also maintains a high level of efficiency.

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 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 four percent of total federal funding for research and development, the agency provides 45 percent of federal support to academic institutions for non-medical 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 processing of pharmaceuticals.

The NSF Strategic Plan for FY 2006-2011 acknowledges and responds to the changing context that is transforming science and education research and education today. 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. The Plan establishes a framework for investment strategies for research and education that directly addresses these issues.

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

NSF leads federal agencies in funding research and education activities based on competitive merit review, with over 88 percent of its research and education funding going to awards selected through a competitive merit review process. In FY 2006, the last year for which complete data exist, NSF awarded more than 10,400 new grants from over 42,300 competitive proposals.

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.

Further, to ensure the highest quality in processing and recommending proposals for awards, NSF also 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 utilize 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.

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 2006, for example, proposals totaling $1.8 billion were declined due to funding constraints 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.

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

Strategic investments intended to achieve long-term outcomes are the target of performance assessments at NSF. 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. Over the past several years, these external evaluations have provided integral information for the assessments conducted using the Program Assessment Rating Tool (PART).

External Evaluations. The NSF Advisory Committee for GPRA Performance Assessment (AC/GPA) leads the annual evaluation of NSF's performance. In FY 2006, the Advisory Committee for Business and Operations (AC/BO) assisted the AC/GPA in the evaluation of the Organizational Excellence goal. The AC/GPA summarized its findings as follows:

> Based on the extensive review of numerous materials provided by the NSF, **the Committee was unanimous in its conclusion that NSF has demonstrated significant achievement for all indicators in the Ideas, Tools, and People goals and as well as the indicators of the Organizational Excellence goal. There was also agreement that NSF has demonstrated quality and relevance on Ideas, Tools, and People. The Committee also found demonstrated quality in all indicators of the Organizational Excellence goal (the evaluation criterion "relevance" is not applicable to Organizational Excellence).**
>
> The NSF portfolio is deep and rich in IDEAS. From novel discoveries in the basic sciences and engineering to educational advancements across the STEM disciplines, the NSF has demonstrated continued commitment to its basic goals of pursuing the highest quality research, in novel and transformative ways, while broadening the participation in science and engineering of people from all parts of society. The R&D programs under the TOOLS performance indicator are important investments and appropriate and deemed to be of high quality. Many of the projects reviewed related to the PEOPLE performance indicators have high relevance to the development of a strong workforce and to public understanding of science. Projects were found to include goals and accomplishments considered to be bold and at the frontiers of science, engineering, and education. The ORGANIZATIONAL EXCELLENCE review found the merit review system to be highly effective, trusted, and respected by participants within the science community. The process is thorough and has well-designed contingencies for handling nonprocedural issues and allows for continuous improvement.

Program Assessment Rating Tool. The PART process has also become a central component of NSF's performance framework. Since its inception, only 15 percent of the PART programs evaluated across federal agencies received the highest rating of "Effective." All NSF programs have been evaluated over the past several years, and each one has received the highest rating of effective. NSF is now exploring the appropriate PART framework for advancing the goals and priorities of the new Strategic Plan.

FY 2008 Budget Request by Strategic Goal

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 2008 Budget Request link directly with the Strategic Outcome Goals established in the NSF Strategic Plan for FY 2006-2011. These four interrelated strategic outcome goals – Discovery, Learning, Research Infrastructure, and Stewardship – establish an integrated strategy to deliver new knowledge at the frontiers, meet vital national needs, and work to achieve the NSF vision. Although these goals are similar to the previous Strategic Plan's goals of Ideas, People, Tools, and Organizational Excellence, the first three are aligned directly with the three strategic priorities recently established in the *National Science Board 2020 Vision for the National Science Foundation*, while the fourth acknowledges NSF's responsibilities as a steward of the taxpayer's investment in science and engineering.

NSF Budget by Strategic Outcome Goal

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Discovery	$2,942.82	$3,086.93	$3,312.96	$226.03	7.3%
Learning	878.99	898.51	938.22	39.71	4.4%
Research Infrastructure	1,508.17	1,685.24	1,813.99	128.75	7.6%
Stewardship	315.82	349.53	363.83	14.30	4.1%
Total, NSF	**$5,645.79**	**$6,020.21**	**$6,429.00**	**$408.79**	**6.8%**

Totals may not add due to rounding.

SUMMARY TABLES AND CHARTS

National Science Foundation
FY 2008 Budget Request to Congress
Summary of Major Changes by Account

(Dollars in Millions)

NSF FY 2007 Request	**$6,020**

Research and Related Activities

Biological Sciences	**+25**

Increases funding for research with emphases on informatics and theoretical biology; supports a new Plant Science Cyberinfrastructure Collaborative to enable new conceptual advances through integrative, computational thinking; supports a new Center for Research on the Environmental and Health Safety of Nanotechnology to examine interactions between nanoparticles and the living world; and supports an increased number of awards. Increases funding for the National Ecological Observatory Network (NEON) to support continued design and planning efforts and key infrastructure.

Computer and Information Science and Engineering	**+47**

Supports new research in computing fundamentals and research to improve our understanding of computer and network systems, supporting larger, experimental projects that promise information technology (IT) systems that are more reliable and robust, have better and more predictable performance, provide useful new services, and exploit the potential of emerging technologies. New investments in software design and productivity are funded. CISE will initiate a new internationally focused program designed to contribute to the development of a competitive, globally aware workforce. In addition, CISE will support pre-construction planning activities for the Global Environment for Networking Innovations (GENI). Support is also provided for the new NSF-wide investment in Cyber-enabled Discovery and Innovation.

Engineering	**+55**

Increases support significantly for core research projects in ENG's five priorities: Complex Engineered and Natural Systems, Energy and the Environment, Innovation, Manufacturing Frontiers, and Nanotechnology. Increased support is also provided for small business research programs, CAREER, and Nanoscale Science and Engineering Centers. Funding for Engineering Research Centers (ERCs) decreases as the number of centers supported drops by four to 15 ERCs as part of the transition to a new generation of ERCs. Support is also provided for the new NSF-wide investment in Cyber-enabled Discovery and Innovation.

Geosciences	**+47**

Increases support for research across the geosciences, with emphases on understanding global environmental issues and natural disasters; support for the research priorities presented in the Ocean Research Priorities Plan; support for operations of a new Scientific Ocean Drilling Vessel; operational support for EarthScope; and operations support for the initial elements of the Ocean Observatories Initiative.

Mathematical and Physical Sciences	**+103**

Increases funding for fundamental research in the MPS disciplines. Themes include cyberinfrastructure, complex systems and emergent behavior, physical sciences at the nanoscale, Physics of the Universe and Elementary Particle Physics, fundamental mathematical and statistical science, and sustainable use of energy and natural resources. Support is increased for facilities design, operation, and instrumentation development. Funds are also targeted for existing programs to strengthen education and broaden participation with an emphasis on discovery-based experiences for undergraduates. Support is also provided for the new NSF-wide investment in Cyber-enabled Discovery and Innovation.

National Science Foundation
FY 2008 Budget Request to Congress
Summary of Major Changes by Account

(Dollars in Millions)

Social, Behavioral and Economic Sciences	**+8**
Increases funding for Science of Science and Innovation Policy (SciSIP); for core disciplinary and interdisciplinary research; for physical systems, brains and human intelligence research that links behavioral and cognitive processes to related advances in neuroscience; and for the new NSF-wide investment in Cyber-enabled Discovery and Innovation to fund SciSIP's interdisciplinary collaboratories and data extraction research.	
Office of Cyberinfrastructure	**+18**
Supports the development and provision of software and services that facilitate complex science and engineering research with an emphasis on enhancing the utility and impact of NSF's parallel investments in high-performance computing and advanced network control and transport mechanisms. Increased funding is also provided for operations and maintenance in support of high-performance computing (HPC) systems in university supercomputing centers. Such centers provide access to HPC resources, coupled with sophisticated user support and training, to a diverse mix of researchers and educators in the academic community. Support is also provided for the new NSF-wide investment in Cyber-enabled Discovery and Innovation.	
Office of International Science and Engineering	**+4**
Increases funding for programs that support the Preparing the Workforce of the 21st Century budget priority, such as International Research Experiences for Students, the International Research Fellowship Program, the East Asia and Pacific Summer Institutes program, and international research experiences for K-12 teachers and students. OISE will fund cyber- and computer-related research and education activities through the new NSF-wide investment in Cyber-enabled Discovery and Innovation.	
Office of Polar Programs	**+27**
Increases support for development of remote sensing instrumentation and the initial operations of the IceCube Neutrino Observatory. OPP will continue to support education and outreach with a focus on International Polar Year (IPY) activities. Support is increased for efforts to diversify resupply of the U.S. Antarctic Program (USAP), support infrastructure improvements at South Pole Station, and to replace USAP software systems. Support increases for safety and health measures. The final components of the South Pole telescope will be delivered and installed. As part of IPY, support will increase for Climate Change research.	
Integrative Activities	**+32**
Increases funding for the Major Research Instrumentation (MRI) program, allowing for growth in the number of awards and an increase in the award cap from $2.0 million to $4.0 million. Funding also provides for an increase in the EPSCoR program.	
U.S. Arctic Research Commission	**+0**
Increases funding by $40,000 to support Commissioners' salaries as well as travel and administrative costs.	
Subtotal, R&RA	**+366**

National Science Foundation
FY 2008 Budget Request to Congress
Summary of Major Changes by Account

(Dollars in Millions)

Education and Human Resources **+34**

EHR will increase funding for Advanced Technological Education (ATE), the STEM Talent Expansion Program (STEP) and the Centers of Research Excellence in Science and Technology (CREST). These efforts are aimed at further strengthening NSF's emphasis on the education of technicians for high-technology fields driving the U.S. economy as well as broadening participation in the science and engineering enterprise. Support will also increase for Graduate Research Fellowships (GRF); Course, Curriculum and Laboratory Improvement (CCLI); Scholarship for Service (SfS); and the National STEM Education Digital Library (NSDL). EHR will add a new Project and Program Evaluation line in the budget to reflect the formal recognition of evaluation efforts across the directorate. Within funding for its portfolio, EHR will provide support for the new NSF-wide Cyber-enabled Discovery and Innovation investment.

Major Research Equipment and Facilities Construction **+4**

NSF requests funding for one new start in FY 2008: the Advanced Laser Interferometer Gravitational Wave Observatory. The FY 2008 Budget Request also provides funding for six ongoing projects: the Alaska Region Research Vessel; the Atacama Large Millimeter Array; the IceCube Neutrino Detector Observatory; the National Ecological Observatory Network; the Ocean Observatories Initiative and the South Pole Station Modernization Project.

Agency Operations and Award Management (formerly Salaries and Expenses) **+4**

Requests usage of full FY 2007 FTE allocation to address the new Stewardship strategic goal. Continued emphasis will be placed on award oversight and management, particularly for large facilities.

National Science Board **+0**

A funding increase of $120,000 will be used for personnel compensation and general operating expenses.

Office of Inspector General **+0**

Increases funding by $490,000 to support higher personnel costs, the escalating costs of audits conducted by CPA firms under contract to OIG, and costs associated with moving contract procurement to the Department of the Treasury.

Total Change, FY 2007 Request to FY 2008 Request	**+409**
NSF FY 2008 Request	**$6,429**

Totals may not add due to rounding.

NSF Summary Tables
FY 2008 Budget Request to Congress

(Dollars in Millions)

NSF by Account	FY 2006 Actual[1/]	FY 2007 Request[1/]	FY 2008 Request	FY 2008 Request: Change over FY 2006 Actual Amount	Percent	FY 2008 Request: Change over FY 2007 Request Amount	Percent
BIO	$580.90	$607.85	$633.00	$52.10	9.0%	$25.15	4.1%
CISE	$496.35	526.69	574.00	77.65	15.6%	47.31	9.0%
ENG *(less SBIR/STTR)*	$486.39	519.67	566.89	80.50	16.6%	47.22	9.1%
SBIR/STTR	$99.07	108.88	116.41	17.34	17.5%	7.53	6.9%
GEO	$703.95	744.85	792.00	88.05	12.5%	47.15	6.3%
MPS	$1,086.61	1,150.30	1,253.00	166.39	15.3%	102.70	8.9%
SBE	$201.23	213.76	222.00	20.78	10.3%	8.24	3.9%
OCI	$127.14	182.42	200.00	72.86	57.3%	17.58	9.6%
OISE[2/]	$42.61	40.61	45.00	2.39	5.6%	4.39	10.8%
OPP	$390.54	438.10	464.90	74.37	19.0%	26.80	6.1%
IA	$233.30	231.37	263.00	29.70	12.7%	31.63	13.7%
U.S. Arctic Research Commission	$1.17	$1.45	$1.49	0.32	27.4%	0.04	2.8%
Research & Related Activities	**$4,449.25**	**$4,765.95**	**$5,131.69**	**$682.44**	**15.3%**	**$365.74**	**7.7%**
Education & Human Resources	**$700.26**	**$716.22**	**$750.60**	**$50.34**	**7.2%**	**$34.38**	**4.8%**
Major Research Equipment & Facilities Construction	**$233.81**	**$240.45**	**$244.74**	**$10.93**	**4.7%**	**$4.29**	**1.8%**
Agency Operations & Award Management	**$247.06**	**$281.82**	**$285.59**	**$38.53**	**15.6%**	**$3.77**	**1.3%**
National Science Board	**$3.94**	**$3.91**	**$4.03**	**$0.09**	**2.2%**	**$0.12**	**3.1%**
Office of Inspector General	**$11.47**	**$11.86**	**$12.35**	**$0.88**	**7.7%**	**$0.49**	**4.1%**
Total, NSF	**$5,645.79**	**$6,020.21**	**$6,429.00**	**$783.21**	**13.9%**	**$408.79**	**6.8%**

Totals may not add due to rounding.

(Dollars in Millions)

NSF by Strategic Goal	FY 2006 Actual	FY 2007 Request	FY 2008 Request	FY 2008 Request: Change over FY 2006 Amount	Percent	FY 2008 Request: Change over FY 2007 Amount	Percent
Discovery	$2,942.82	$3,086.93	$3,312.96	$370.14	12.6%	$226.03	7.3%
Learning	$878.99	898.51	938.22	59.23	6.7%	39.71	4.4%
Research Infrastructure	$1,508.17	1,685.24	1,813.99	305.82	20.3%	128.75	7.6%
Stewardship	$315.82	349.53	363.83	48.01	15.2%	14.30	4.1%
Total, NSF	**$5,645.79**	**$6,020.21**	**$6,429.00**	**$783.21**	**13.9%**	**$408.79**	**6.8%**

Totals may not add due to rounding.

[1/] The FY 2006 Actuals and FY 2007 Request as presented here reflect the transfer of EPSCoR from Education and Human Resources to Research and Related Activities.

[2/] OISE and Discovery FY 2006 Actual includes $7.73 million, and AOAM and Stewardship FY 2006 Actual includes $250,000, provided to NSF by the U.S. State Department for an award to the U.S. Civilian Research and Development Foundation.

National Science Foundation
By Strategic Outcome Goal and Account
FY 2008 Budget Request to Congress

(Dollars in Millions)

			FY 2008 Request								
								Change over FY 2006 Actual		Change over FY 2007 Request	
NSF Accounts	**FY 2006 Actual[1/]**	**FY 2007 Request[1/]**	**Discovery**	**Learning**	**Research Infrastructure**	**Stewardship**	**FY 2008 Request**	Amount	Percent	Amont	Percent
FY 2006 Actual	**$5,645.79**		**$2,942.82**	**$878.99**	**$1,508.17**	**$315.82**					
FY 2007 Request		**$6,020.21**	**$3,086.93**	**$898.51**	**$1,685.24**	**$349.53**					
BIO	580.90	607.85	447.78	46.94	132.28	6.00	633.00	52.10	9.0%	25.15	4.1%
CISE	496.35	526.69	480.12	47.23	39.08	7.57	574.00	77.65	15.6%	47.31	9.0%
ENG *(less SBIR/STTR)*	486.39	519.67	473.47	53.35	31.57	8.50	566.89	80.50	16.6%	47.22	9.1%
SBIR/STTR	99.07	108.88	116.41	-	-	-	116.41	17.34	17.5%	7.53	6.9%
GEO	703.95	744.85	412.26	31.39	340.60	7.75	792.00	88.05	12.5%	47.15	6.3%
MPS	1,086.61	1,150.30	861.46	64.90	315.29	11.35	1,253.00	166.39	15.3%	102.70	8.9%
SBE	201.23	213.76	163.34	9.27	45.59	3.80	222.00	20.78	10.3%	8.24	3.9%
OCI	127.14	182.42	14.75	4.00	179.20	2.05	200.00	72.86	57.3%	17.58	9.6%
OISE[2/]	42.61	40.61	30.05	12.60	-	2.35	45.00	2.39	5.6%	4.39	10.8%
OPP	390.54	438.10	106.48	5.39	350.74	2.29	464.90	74.37	19.0%	26.80	6.1%
IA	233.30	231.37	134.14	9.19	118.91	0.76	263.00	29.70	12.7%	31.63	13.7%
U.S. Arctic Research Commission	$1.17	$1.45	1.49	-	-	-	$1.49	0.32	27.4%	0.04	2.8%
Research & Related Activities	**$4,449.25**	**$4,765.95**	**$3,241.75**	**$284.26**	**$1,553.26**	**$52.42**	**$5,131.69**	**$682.44**	**15.3%**	**$365.74**	**7.7%**
Education & Human Resources	**$700.26**	**$716.22**	**$71.21**	**$653.96**	**$15.99**	**$9.44**	**$750.60**	**$50.34**	**7.2%**	**$34.38**	**4.8%**
Major Research Equipment & Facilities Construction	**$233.81**	**$240.45**	-	-	**$244.74**	-	**$244.74**	**$10.93**	**4.7%**	**$4.29**	**1.8%**
Agency Operations & Award Management	**$247.06**	**$281.82**	-	-	-	**$285.59**	**$285.59**	**$38.53**	**15.6%**	**$3.77**	**1.3%**
National Science Board	**$3.94**	**$3.91**	-	-	-	**$4.03**	**$4.03**	**$0.09**	**2.2%**	**$0.12**	**3.1%**
Office of Inspector General	**$11.47**	**$11.86**	-	-	-	**$12.35**	**$12.35**	**$0.88**	**7.7%**	**$0.49**	**4.1%**
Total, National Science Foundation	**$5,645.79**	**$6,020.21**	**$3,312.96**	**$938.22**	**$1,813.99**	**$363.83**	**$6,429.00**	**$783.21**	**13.9%**	**$408.79**	**6.8%**
H-1B Visa	*$99.40*	*$100.00*					*$100.00*				
Total NSF, Including H-1B Visa	*$5,745.19*	*$6,120.21*	*$3,312.96*	*$938.22*	*$1,813.99*	*$363.83*	*$6,529.00*	*$783.81*	*13.6%*	*$408.79*	*6.7%*
Percent Increase over Prior Year, excluding H-1B Visa			**7.3%**	**4.4%**	**7.6%**	**4.1%**					

Totals may not add due to rounding.

[1/] The FY 2006 Actuals and FY 2007 Request as presented here reflect the transfer of EPSCoR from Education and Human Resources to Research and Related Activities.

[2/] OISE and Discovery FY 2006 Actual includes $7.73 million, and AOAM and Stewardship FY 2006 Actual includes $250,000, provided to NSF by the U.S. State Department for an award to the U.S. Civilian Research and Development Foundation.

National Science Foundation
Research Infrastructure Summary
FY 2008 Budget Request to Congress

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Academic Research Fleet	$76.21	$97.70	$97.60	-$0.10	-0.1%
Regional Class Research Vessels	*3.63*	*15.10*	*14.00*	-1.10	-7.3%
RHOV Construction (R/V Alvin Replacement)	*8.63*	*5.10*	*3.00*	*-2.10*	*-41.2%*
R/V Langseth Construction (R/V Ewing Replacement)	*1.74*	-	-	-	*N/A*
Other Academic Research Fleet	*62.21*	*77.50*	*80.60*	*3.10*	*4.0%*
Advanced Modular Incoherent Scatter Radar[/1]	7.50	-	-	-	N/A
Cornell Electron Storage Ring	14.62	14.71	14.71	-	-
Gemini	18.18	20.00	20.50	0.50	2.5%
Incorporated Research Institutions for Seismology	11.41	12.90	11.40	-1.50	-11.6%
Integrated Ocean Drilling Pgm/Ocean Drilling Program[/2]	32.19	6.50	4.64	-1.86	-28.6%
Large Hadron Collider	13.36	18.00	18.00	-	-
Laser Interferometer Gravitational Wave Observatory	31.68	33.00	28.20	-4.80	-14.5%
Major Research Equipment & Facilities Construction[/3]	250.75	294.10	335.25	41.15	14.0%
Major Research Instrumentation	88.39	90.00	114.44	24.44	27.2%
National Astronomy & Ionosphere Center	12.15	12.16	12.15	-0.01	-0.1%
National Center for Atmospheric Research	84.51	86.85	90.87	4.02	4.6%
National High Magnetic Field Laboratory	25.74	26.50	29.00	2.50	9.4%
National Nanofabrication Infrastructure Network (NNIN)	14.43	13.89	13.89	-	-
National Optical Astronomy Observatories	36.91	40.05	43.18	3.13	7.8%
National Radio Astronomy Observatories	50.74	50.74	52.74	2.00	3.9%
National STEM Digital Library	17.82	18.59	17.50	-1.09	-5.9%
National Superconducting Cyclotron Laboratory	17.34	17.60	19.50	1.90	10.8%
Network for Earthquake Engineering Simulation	21.03	21.27	22.17	0.90	4.2%
Polar Environment, Safety and Health	5.01	5.92	6.48	0.56	9.5%
Polar Facilities and Logistics	294.25	330.51	341.26	10.75	3.3%
Research Resources	236.48	265.16	292.99	27.83	10.5%
Science and Technology Policy Institute / RaDiUS	4.28	4.28	4.47	0.19	4.4%
Science Resources Statistics	25.75	27.31	28.60	1.29	4.7%
Shared Cyberinfrastructure Tools	103.76	164.72	179.20	14.48	8.8%
Other Facilities[/4]	13.69	12.78	15.25	2.47	19.3%
RESEARCH INFRASTRUCTURE TOTAL	**$1,508.17**	**$1,685.24**	**$1,813.99**	**$128.75**	**7.6%**

Totals may not add due to rounding.

NOTE: The structure displayed is consistent with the new 2006-2011 Strategic Plan.

[/1] Final funding for construction of the Advanced Modular Inocherent Scatter Radar (AMISR) facility was provided in FY 2006. Operations and

[/2] Funding is included on this line for IODP, and the FY 2006-FY 2007 continued phase out of program and contract activities for ODP, predecessor to

[/3] Funding levels for MREFC projects in this table include support for concept and development associated with these projects, initial support for

[/4] Other Facilities includes other physics and materials research facilities and other related costs.

National Science Foundation
Selected Crosscutting Programs
FY 2008 Budget Request to Congress

(Dollars in Millions)

Selected Crosscutting Programs		FY 2006 Actual	FY 2007 Request	FY 2008 Request	FY 2008 Request Change over Amount	Change over Percent	Change over Amount	Change over Percent
ADVANCE	Research & Related Activities	19.52	19.72	19.53	0.01	0.03%	-0.19	-1.0%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$19.52**	**$19.72**	**$19.53**	**$0.01**	**0.03%**	**-$0.19**	**-1.0%**
Faculty Early Career Development - CAREER	Research & Related Activities	175.99	149.46	156.52	-19.47	-11.1%	7.06	4.7%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$175.99**	**$149.46**	**$156.52**	**-$19.47**	**-11.1%**	**$7.06**	**4.7%**
Graduate Research Fellowships - GRF	Research & Related Activities	8.17	8.06	8.06	-0.11	-1.3%	-	-
	Education & Human Resources	86.35	88.57	97.50	11.15	12.9%	8.93	10.1%
	Total, NSF	**$94.52**	**$96.63**	**$105.56**	**$11.04**	**11.7%**	**$8.93**	**9.2%**
Graduate Teaching Fellowships in K-12 Education - GK-12	Research & Related Activities	7.73	8.86	8.86	1.13	14.6%	-	-
	Education & Human Resources	42.96	47.00	47.00	4.04	9.4%	-	-
	Total, NSF	**$50.69**	**$55.86**	**$55.86**	**$5.17**	**10.2%**		-
Integrative Graduate Education and Research Training - IGERT	Research & Related Activities	42.40	42.40	42.40	-		-	-
	Education & Human Resources	23.76	25.00	25.00	1.24	5.2%	-	-
	Total, NSF	**$66.16**	**$67.40**	**$67.40**	**$1.24**	**1.9%**		-
Long-Term Research Sites - LTER	Research & Related Activities	23.20	24.72	24.72	1.52	6.6%	-	-
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$23.20**	**$24.72**	**$24.72**	**$1.52**	**6.6%**		-
Postodoctoral Programs	Research & Related Activities	16.79	16.05	16.61	-0.18	-1.1%	0.56	3.5%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$16.79**	**$16.05**	**$16.61**	**-$0.18**	**-1.1%**	**$0.56**	**3.5%**
Research Experience for Teachers - RET	Research & Related Activities	7.68	8.51	9.64	1.96	25.5%	1.13	13.3%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$7.68**	**$8.51**	**$9.64**	**$1.96**	**25.5%**	**$1.13**	**13.3%**
Research Experience for Undergraduates - REU	Research & Related Activities	58.71	56.92	56.94	-1.77	-3.0%	0.02	0.0%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$58.71**	**$56.92**	**$56.94**	**-$1.77**	**-3.0%**	**$0.02**	**0.0%**
Research Experience for Undergraduates - REU - Sites Only	Research & Related Activities	41.41	35.64	35.13	-6.28	-15.2%	-0.51	-1.4%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$41.41**	**$35.64**	**$35.13**	**-$6.28**	**-15.2%**	**-$0.51**	**-1.4%**
Research Experience for Undergraduates - REU - Supplements Only	Research & Related Activities	17.31	21.28	21.81	4.50	26.0%	0.53	2.5%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$17.31**	**$21.28**	**$21.81**	**$4.50**	**26.0%**	**$0.53**	**2.5%**
Research Opportunity Awards - ROA	Research & Related Activities	1.28	1.17	1.18	-0.10	-7.8%	0.01	0.9%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$1.28**	**$1.17**	**$1.18**	**-$0.10**	**-7.8%**	**$0.01**	**0.9%**
Research in Undergraduate Institutions - RUI	Research & Related Activities	28.57	29.78	30.32	1.75	6.1%	0.54	1.8%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$28.57**	**$29.78**	**$30.32**	**$1.75**	**6.1%**	**$0.54**	**1.8%**
Science and Technology Centers - STCs	Research & Related Activities	62.01	66.58	65.30	3.29	5.3%	-1.28	-1.9%
	Education & Human Resources	-	-	-	-	N/A	-	N/A
	Total, NSF	**$62.01**	**$66.58**	**$65.30**	**$3.29**	**5.3%**	**-$1.28**	**-1.9%**

Totals may not add due to rounding.

National Science Foundation
Funding for Priority Areas: FY 2000 - FY 2009

(Dollars in Millions)

	FY 2000 Actual	FY 2001 Actual	FY 2002 Actual	FY 2003 Actual	FY 2004 Actual	FY 2005 Actual	FY 2006 Actual	FY 2007 Request	FY 2008 Request	FY 2009 Request
Biocomplexity in the Environment	$50.00	$54.88	$58.96	$70.28	$104.11	$99.17	$80.03	$42.58	-	-
Information Technology Research	126.00	261.17	277.22	335.11	308.8	-	-	-	-	-
Mathematical Sciences	-	-	30.00	60.42	91.56	89.56	88.81	78.45	-	-
Nanoscale Science and Engineering	-	149.68	192.28	222.46	256.05	288.33	203.38	-	-	-
Human and Social Dynamics	-	-	-	4.46	30.07	38.31	39.47	41.45	37.95	37.95
Total, Priority Areas	$176.00	$465.73	$558.46	$692.73	$790.59	$515.37	$411.69	$162.48	$37.95	$37.95

Funding for the Biocomplexity in the Environment and Mathematical Sciences Priority Areas will return to core programs 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. 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 2006 Estimate	FY 2007 Estimate	FY 2008 Request Estimate
Statistics for Competitive Awards			
Number	10,430	10,765	11,300
Funding Rate	25%	24%	26%
Statistics for Research Grants			
Number of Research Grants	6,635	6,900	7,435
Funding Rate	21%	20%	21%
Median Annualized Award Size	$106,800	$109,900	$110,800
Average Annualized Award Size	$134,800	$142,900	$147,200
Average Duration (years)	2.9	2.9	3.0

National Science Foundation
NSTC CROSSCUTS
FY 2008 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 2006 Actual	FY 2007 Request	FY 2008 Request	FY 2006 Actual	FY 2007 Request	FY 2008 Request	FY 2006 Actual	FY 2007 Request	FY 2008 Request
BIO	$15.10	$15.10	$15.10	$77.00	$83.50	$83.50	$49.00	$52.55	$55.55
CISE	-	-	-	496.35	526.69	574.00	10.42	12.87	11.00
ENG	1.00	1.00	1.00	11.20	11.20	21.20	127.77	137.02	139.02
GEO	149.35	157.72	160.72	14.56	14.56	14.56	9.00	9.65	9.65
MPS	5.45	5.45	5.45	68.93	69.00	76.96	158.24	156.42	169.91
SBE	15.48	15.48	15.48	12.47	12.47	14.47	1.56	1.67	1.67
OCI	-	-	-	127.14	182.42	200.00	-	-	-
OISE	-	-	-	-	-	-	0.48	-	-
OPP	10.50	10.50	10.50	-	-	-	-	-	-
IA	-	-	-	-	-	-	-	-	-
USARC	-	-	-	-	-	-	-	-	-
R&RA	**$196.88**	**$205.25**	**$208.25**	**$807.65**	**$899.84**	**$984.69**	**$356.47**	**$370.18**	**$386.80**
EHR	**-**	**-**	**-**	**$3.88**	**$3.90**	**$9.00**	**$3.24**	**$3.00**	**$3.10**
NSF Total	**$196.88**	**$205.25**	**$208.25**	**$811.53**	**$903.74**	**$993.69**	**$359.71**	**$373.18**	**$389.90**

National Science Foundation
Homeland Security Activities
FY 2008 Budget Request to Congress

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Critical Infrastructure Protection	$283.98	$304.54	$315.99	$11.45	3.8%
Research to Combat Bioterrorism	27.00	28.00	25.00	-3.00	-10.7%
Ecology of Infectious Diseases	*10.00*	*10.00*	*10.00*	-	-
Microbial Genome Sequencing	*17.00*	*18.00*	*15.00*	*-3.00*	*-16.7%*
Counterterrorism	27.65	47.00	27.00	-20.00	-42.6%
Physical / Information Technology Security	3.47	6.37	7.37	1.00	15.7%
TOTAL, NSF	**$342.10**	**$385.91**	**$375.36**	**-$10.55**	**-2.7%**

NSF Programs to Broaden Participation
FY 2008 Budget Request to Congress

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Programs for Minority Individuals	**$72.32**	**$82.80**	**$86.19**	**$3.39**	**4.1%**
Alliances for Graduate Education and the Professoriate (AGEP)	14.57	19.00	19.00	0.00	0.0%
Graduate Research Fellowships to Members of Underrepresented Groups - EHR	7.17	7.35	8.09	0.74	10.1%
Louis Stokes Alliances for Minority Participation (LSAMP)	36.14	40.00	40.00	0.00	0.0%
GEO LSAMP Linkages	0.54	1.00	1.00	0.00	0.0%
Minority Post-Docs	2.49	3.40	3.40	0.00	0.0%
BIO Minority Post-Docs	*2.48*	*2.50*	*2.50*	*0.00*	*0.0%*
SBE Minority Post-Docs	*0.01*	*0.90*	*0.90*	*0.00*	*0.0%*
Next Generation Workforce (NGW) - SBE	0.96	1.00	1.00	0.00	0.0%
Opportunities to Enhance Diversity in the Geosciences (OEDG)	5.03	4.60	4.60	0.00	0.0%
Broadening Participation in the Biological Sciences	4.97	6.00	8.65	2.65	44.2%
Significant Opportunities in Atmospheric Research and Science (SOARS) - GEO	0.45	0.45	0.45	0.00	0.0%
Programs for Minority Institutions	**$62.42**	**$76.85**	**$83.96**	**$7.11**	**9.3%**
Mentoring in Biology	3.12	5.00	5.00	0.00	0.0%
Centers of Research Excellence in Science and Technology (CREST)	17.79	25.00	29.53	4.53	18.1%
Historically-Black Colleges and Universities-Undergraduate Program (HBCU-UP)	25.66	30.00	30.00	0.00	0.0%
HBCU-UP - R&RA	*0.11*	*0.00*	*0.00*	*0.00*	N/A
HBCU-UP - EHR	*25.55*	*30.00*	*30.00*	*0.00*	*0.0%*
Partnerships for Research and Education in Materials (PREM) - MPS	5.10	4.00	6.58	2.58	64.5%
Tribal Colleges and Universities Program (TCUP)	10.75	12.85	12.85	0.00	0.0%
Gender-Based Programs	**$37.34**	**$38.78**	**$38.59**	**-$0.19**	**-0.5%**
ADVANCE	19.52	19.72	19.53	-0.19	-1.0%
Graduate Research Fellowships - Women in Engineering and Computer Science	8.17	8.06	8.06	0.00	0.0%
Research on Gender in Science and Engineering (GSE)	9.65	11.00	11.00	0.00	0.0%
Programs for Persons with Disabilities	**$5.30**	**$6.00**	**$6.00**	**$0.00**	**0.0%**
Research in Disabilities Education (RDE)	5.30	6.00	6.00	0.00	0.0%
Other Broadening Participation Programs	**$443.05**	**$436.91**	**$443.98**	**$7.07**	**1.6%**
Advanced Technology Education (ATE)	45.40	46.50	51.62	5.12	11.0%
Broadening Participation in Computing (BPC)	14.16	14.00	14.00	0.00	0.0%
Cyberinfrastructure Training, Education, Advancement and Mentoring (CI-TEAM)	10.00	10.00	0.00	-10.00	-100.0%
Experimental Program to Stimulate Competitive Research (EPSCoR)	98.22	100.00	107.00	7.00	7.0%
Graduate Research Diversity (GRD) - ENG	0.50	0.75	0.75	0.00	0.0%
H-1B Nonimmigrant Petitioner Fee programs	99.40	100.00	100.00	0.00	0.0%
Informal Science Education (ISE)	62.65	66.00	66.00	0.00	0.0%
Math and Science Partnership (MSP)	63.17	46.00	46.00	0.00	0.0%
Noyce Scholarships	8.91	10.00	10.00	0.00	0.0%
OISE Broadening Participation	0.91	1.00	1.00	0.00	0.0%
Partnerships for Innovation (PFI)	9.34	9.19	9.19	0.00	0.0%
Research Partnerships for Diversity (RPD) - MPS	2.90	3.25	5.00	1.75	53.8%
Tribal College Pathways - ENG	0.20	0.25	0.25	0.00	0.0%
Undergraduate Research Collaboratives (URC) - MPS	1.93	3.47	3.47	0.00	0.0%
Science, Technology, Engineering and Math Talent Expansion Program (STEP)	25.36	26.50	29.70	3.20	12.1%
Subtotal, R&RA	**$188.63**	**$195.14**	**$198.93**	**$3.79**	**1.9%**
Subtotal, EHR	**$332.40**	**$346.20**	**$359.79**	**$13.59**	**3.9%**
Subtotal, H-1B Nonimmigrant Petitioner Fees	**$99.40**	**$100.00**	**$100.00**	**$0.00**	**0.0%**
TOTAL, NSF	**$620.43**	**$641.34**	**$658.72**	**$17.38**	**2.7%**

Totals may not add due to rounding.

National Science Foundation
Learning Funding by Level of Education
FY 2008 Budget Request to Congress

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
K-12 Programs	**$165.63**	**$149.77**	**$150.36**	**$0.59**	**0.4%**
Undergraduate Programs	**276.82**	**287.06**	**300.16**	**13.10**	**4.6%**
Graduate & Professional Programs	**301.38**	**312.08**	**326.31**	**14.23**	**4.6%**
Multi-level and Other Programs	**135.15**	**149.60**	**161.39**	**11.79**	**7.9%**
TOTAL, NSF	**$878.99**	**$898.51**	**$938.22**	**$39.71**	**4.4%**

Totals may not add due to rounding.

Number of People Involved in NSF Activities

It is estimated that in FY 2008 over 240,000 people will be 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 2006 Estimate	FY 2007 Estimate	FY 2008 Request Estimate
Senior Researchers	34,915	35,675	37,285
Other Professionals	13,140	13,675	14,380
Postdoctoral Associates	5,540	5,845	6,125
Graduate Students	31,990	32,990	34,475
Undergraduate Students	21,345	22,350	23,530
K-12 Students	22,850	23,320	25,350
K-12 Teachers	96,040	96,535	100,590
Total, Number of People	225,820	230,390	241,735

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 98 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 13 percent of these students receive support through programs such as NSF Graduate Research Fellowships, Integrative Graduate Education and Research Traineeship, 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.

NSF By Account

(Actual Dollars in Millions - Current Dollars)

Fiscal Year	Research & Related Activities	Education & Human Resources	Academic Research Infrastructure	Major Research Equipment & Facilities Construction	Office of Inspector General	Agency Operations & Award Management	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	-	2.33	96.35	-	2,026.06
1991	1,868.45	331.91	39.02	-	2.89	101.23	-	2,343.49
1992	1,940.48	459.44	33.36	-	3.86	109.99	-	2,547.13
1993	2,046.31	505.06	49.75	34.07	3.69	110.84	-	2,749.73
1994	2,168.36	569.03	105.38	17.04	3.92	123.49	-	2,987.21
1995	2,281.46	611.88	117.46	126.00	4.46	129.01	-	3,270.27
1996	2,327.80	601.16	70.89	70.00	3.98	132.50	-	3,206.33
1997	2,433.93	619.14	30.02	76.13	5.33	134.27	-	3,298.82
1998	2,572.62	633.16	-	78.21	4.80	136.95	-	3,425.73
1999	2,821.61	662.48	-	56.71	5.41	144.08	-	3,690.28
2000	2,979.90	683.58	-	105.00	5.60	149.28	-	3,923.36
2001	3,372.30	795.42	-	119.24	6.58	166.33	-	4,459.87
2002	3,615.97	866.11	-	115.35	6.70	169.93	-	4,774.06
2003	4,054.43	934.88	-	179.03	8.70	189.42	2.88	5,369.34
2004	4,293.34	944.10	-	183.96	9.47	218.92	2.22	5,652.01
2005	4,234.82	843.54	-	165.14	10.17	223.45	3.65	5,480.77
2006	4,351.03	798.48	-	233.81	11.47	247.06	3.94	5,645.79
2007 Request	4,665.95	816.22	-	240.45	11.86	281.82	3.91	6,020.21
2008 Request[1/]	5,131.69	750.60	-	244.74	12.35	285.59	4.03	6,429.00

[1/] EPSCoR funding will be moved from Education and Human Resources to Research and Related Activities in FY 2008.

NSF By Account

(FY Actuals - FY 2006 Constant Dollars in Millions)

Fiscal Year	Research & Related Activities	Education & Human Resources	Academic Research Infrastructure	Major Research Equipment & Facilities Construction	Office of Inspector General	Agency Operations & Award Management	National Science Board	NSF
1951	0.00	-	-	-	-	0.02	-	0.02
1952	0.22	0.24	-	-	-	0.08	-	0.54
1953	0.34	0.22	-	-	-	0.14	-	0.70
1954	0.72	0.30	-	-	-	0.25	-	1.27
1955	1.42	0.33	-	-	-	0.25	-	2.00
1956	1.78	0.58	-	-	-	0.28	-	2.63
1957	3.76	2.44	-	-	-	0.40	-	6.61
1958	4.82	3.38	-	-	-	0.52	-	8.72
1959	11.87	10.97	-	-	-	0.94	-	23.77
1960	16.00	11.54	-	-	-	1.18	-	28.72
1961	19.10	11.65	-	-	-	1.39	-	32.14
1962	32.18	14.59	-	-	-	1.67	-	48.44
1963	41.16	17.11	-	-	-	2.04	-	60.32
1964	45.66	19.52	-	-	-	2.29	-	67.47
1965	54.67	23.31	-	-	-	2.54	-	80.52
1966	64.97	24.58	-	-	-	2.59	-	92.14
1967	66.88	25.18	-	-	-	2.87	-	94.92
1968	74.01	28.47	-	-	-	3.25	-	105.73
1969	64.73	27.21	-	-	-	3.64	-	95.58
1970	73.74	29.46	-	-	-	4.59	-	107.79
1971	90.38	25.69	-	-	-	5.33	-	121.40
1972	123.62	24.02	-	-	-	6.29	-	153.94
1973	138.97	16.65	-	-	-	7.66	-	163.27
1974	152.98	23.15	-	-	-	9.08	-	185.21
1975	184.07	23.44	-	-	-	11.99	-	219.51
1976	210.42	21.21	-	-	-	14.34	-	245.97
1977	245.26	27.10	-	-	-	16.62	-	288.98
1978	286.20	28.77	-	-	-	18.97	-	333.94
1979	333.28	33.85	-	-	-	23.05	-	390.18
1980	383.13	36.65	-	-	-	26.66	-	446.45
1981	452.59	38.05	-	-	-	29.76	-	520.40
1982	488.61	14.07	-	-	-	33.93	-	536.61
1983	568.09	12.89	-	-	-	36.84	-	617.81
1984	684.81	36.61	-	-	-	38.53	-	759.95
1985	807.22	54.37	-	-	-	43.20	-	904.79
1986	816.84	56.33	-	-	-	44.13	-	917.30
1987	907.71	69.26	-	-	-	49.02	-	1,026.00
1988	963.14	101.95	-	-	-	54.92	-	1,120.01
1989	1,081.10	131.08	-	-	-	61.66	-	1,273.84
1990	1,188.53	161.41	0.29	-	1.63	67.50	-	1,419.36
1991	1,358.08	241.25	28.36	-	2.10	73.58	-	1,703.36
1992	1,445.91	342.34	24.85	-	2.87	81.96	-	1,897.94
1993	1,559.35	384.87	37.91	25.96	2.81	84.46	-	2,095.37
1994	1,687.87	442.94	82.03	13.27	3.05	96.13	-	2,325.28
1995	1,813.29	486.32	93.35	100.14	3.54	102.54	-	2,599.19
1996	1,885.64	486.97	57.43	56.70	3.22	107.33	-	2,597.29
1997	2,006.03	510.29	24.74	62.75	4.39	110.66	-	2,718.87
1998	2,146.07	528.18	-	65.24	4.00	114.24	-	2,857.73
1999	2,384.67	559.89	-	47.92	4.57	121.77	-	3,118.83
2000	2,569.33	589.39	-	90.53	4.83	128.71	-	3,382.79
2001	2,976.28	702.01	-	105.24	5.81	146.80	-	3,936.13
2002	3,252.44	779.04	-	103.75	6.03	152.85	-	4,294.10
2003	3,720.58	857.90	-	164.29	7.98	173.82	2.64	4,927.22
2004	4,041.62	888.75	-	173.17	8.91	206.08	2.09	5,320.63
2005	4,108.12	818.30	-	160.20	9.87	216.76	3.54	5,316.79
2006	4,351.03	798.48	-	233.81	11.47	247.06	3.94	5,645.79
2007 Request	4,784.23	836.91	-	246.55	12.16	288.96	4.01	6,172.82
2008 Request[1/]	5,389.20	788.27	-	257.02	12.97	299.92	4.23	6,751.61

[1/] EPSCoR funding will be moved from Education and Human Resources to Research and Related Activities in FY 2008.

Current Authorizations -- National Science Foundation

LEGISLATION	FY 2006 Actual	Authorization Levels FY 2006	Authorization Levels FY 2007	Authorization Levels FY 2008	FY 2007 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)	$5,645.79	$8,519.78	$9,839.26		
Cyber Security Research and Development Act (P.L.107-305)					
Program Specific					
Computer and Network Security Capacity Building Grants	$25.00	$20.00	$20.00		
Computer and Network Security Research Centers	$14.00	$36.00	$36.00		
Computer and Network Security Research Grants	$35.00 [3]	$52.00	$60.00		
Graduate Traineeships in Computer and Network Security	$10.41	$20.00	$20.00		
21st Century Nanotechnology Research and Development Act (P.L.108-153)					
Nanoscale Science and Engineering	$359.71	$424.00	$449.00	$476.00	
National Earthquake Hazards Reduction Program Reauthorization Act of 2003 (P.L.108-360)	$53.77	$39.14	$40.31	$41.52	
National Windstorm Impact Reduction Act of 2004 (P.L.108-360)	$6.29	$8.70	$9.40	$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	$88.57				
Small Business Technology Transfer (STTR) Program	$10.50	0.3% of research funds (STTR)			

[1] Organic language establishing NSF, authorization and appropriation language may not correspond to current accounts and programs.
[2] FY 2007 appropriations have not yet been enacted.
[3] Excludes graduate student support for US citizens and permanent residents.

RESEARCH AND RELATED ACTIVITIES $5,131,690,000

The FY 2008 Budget Request for the Research and Related Activities (R&RA) Appropriation is $5,131.69 million, an increase of $365.74 million, or 7.7 percent, above the FY 2007 Request of $4,765.95 million. The presentation here reflects the transfer of the Experimental Program to Stimulate Competitive Research (EPSCoR) from Education and Human Resources to R&RA. Support from the R&RA Appropriation enables U.S. leadership and progress across the frontiers of scientific and engineering research and education.

As global competition in science and engineering becomes more intense, sustained focus on high-risk, high-reward research is more critical than ever. NSF's investments lay the foundation for revolutionary technologies, tackle difficult challenges of enormous social and economic significance, and expand the transformational power of science, engineering, and education. To meet the challenges set forth in the American Competitiveness Initiative (ACI), the R&RA portfolio for FY 2008 prioritizes innovations at the frontiers of knowledge with special emphasis in this Request on the physical and computer sciences and engineering.

Research and Related Activities
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Biological Sciences	$580.90	$607.85	$633.00	$25.15	4.1%
Computer and Information Science and Engineering	496.35	526.69	574.00	47.31	9.0%
Engineering	585.46	628.55	683.30	54.75	8.7%
Geosciences	703.95	744.85	792.00	47.15	6.3%
Mathematical and Physical Sciences	1,086.61	1,150.30	1,253.00	102.70	8.9%
Social, Behavioral and Economic Sciences	201.23	213.76	222.00	8.24	3.9%
Office of Cyberinfrastructure	127.14	182.42	200.00	17.58	9.6%
Office of International Science and Engineering[1]	42.61	40.61	45.00	4.39	10.8%
Office of Polar Programs	390.54	438.10	464.90	26.80	6.1%
Integrative Activities[2]	233.30	231.37	263.00	31.63	13.7%
U.S. Arctic Research Commission	1.17	1.45	1.49	0.04	2.8%
Total, Research and Related Activities	$4,449.25	$4,765.95	$5,131.69	$365.74	7.7%

Totals may not add due to rounding.

[1]OISE FY 2006 Actual includes $7.73 million provided to NSF by the U.S. Department of State for an award to the U.S. Civilian Research and Development Foundation.

[2]Includes funding for EPSCoR for all years shown for comparability. The FY 2008 Request for R&RA includes $107.0 million for EPSCoR. Prior to FY 2008, the program was funded through the Education and Human Resources appropriation.

Appropriation 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; $5,131,690,000, to remain available until September 30, 2009, of which not to exceed $510,000,000 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.

Research and Related Activities
FY 2008 Summary Statement
(Dollars in Millions)

Research and Related Activities	Enacted/ Request	Rescission	Carryover/ Recoveries	Transfers[1]	Total Resources	EPSCoR	Total Adjusted Resources	Obligations Incurred/ Est.[2]
FY 2006 Appropriation	$4,387.52	-$56.04	$15.73	$7.73	$4,354.94	$98.22	$4,453.16	$4,449.25
FY 2007 Request	4,665.95	-	3.90	-	4,669.85	100.00	4,769.85	4,769.85
FY 2008 Request	5,131.69	-	-	-	-	-	5,131.69	5,131.69
$ Change from FY 2007								$361.84
% Change from FY 2007								7.6%

Subtotals may not add due to rounding.
[1]Transferred from the U.S. International Development Cooperation Agency for an award to the U.S. Civilian Research and Development Foundation.
[2]The FY 2008 Request for R&RA includes $107.0 million for EPSCoR. Prior to FY 2008, EPSCoR was funded through the Education and Human Resources appropriation.

Adjustments to Base

In FY 2006 and FY 2007, $98.22 million and $100.0 million, respectively, are presented for EPSCoR in the Integrative Activities activity within the R&RA appropriation. EPSCoR funding is included in the FY 2008 Request for R&RA.

Explanation of Carryover

Within the Research and Related Activities appropriation, a total of $3.90 million was carried forward into FY 2007. This includes $2.06 million in Integrative Activities for the Science of Learning Centers and $311,512 for the Science and Technology Centers. The Directorate for Engineering carried forward $882,287 within the Small Business Innovation Research program and $24,776 within the Small Business Technology Transfer program. The Office of Polar Programs carried forward $141,652 for Antarctic Infrastructure and Logistics Support. The remaining amounts are from several awards in various programs that were not ready for obligation in FY 2006.

RESEARCH AND RELATED ACTIVITIES
FY 2008 Performance Highlights

The table below shows the strategic planning and evaluation framework for activities funded through the R&RA appropriation. This framework was established in the NSF Strategic Plan for FY 2006-2011. NSF's strategic outcome goals are assessed annually by the Advisory Committee for GPRA Performance Assessment. Investments are assessed further using the Program Assessment Rating Tool (PART). Additional details are available in the Performance Information section of this document.

Research and Related Activities
By Strategic Outcome Goal
(Dollars in Millions)

	FY 2006 Actuals	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Discovery[1]	$2,873.88	$3,020.80	$3,241.75	$220.95	7.3%
Learning	268.60	273.59	284.26	10.67	3.9%
Research Infrastructure	1,259.54	1,429.27	1,553.26	123.99	8.7%
Stewardship	47.24	42.29	52.42	10.13	24.0%
Total, NSF	$4,449.25	$4,765.95	$5,131.69	$365.74	7.7%

Totals may not add due to rounding.

[1]Includes funding for EPSCoR for all years shown for comparability. The FY 2008 Request for R&RA includes $107.0 million for EPSCoR. Prior to FY 2008, the program was funded through the Education and Human Resources appropriation.

As part of the 2008 budget process, NSF completed PART reviews of three of its investment areas noted below. All three were rated "effective".

- **Capability Enhancement (CE).** The CE program enhances the capability of individuals, institutions, and small businesses to conduct high quality, competitive science and engineering research, education, and technological innovation. CE component programs are: The Centers of Research Excellence in Science and Technology and its Historically Black Colleges and Universities Research Infrastructure in Science and Engineering activity; the Experimental Program to Stimulate Competitive Research; the Small Business Innovation Research and Small Business Technology Transfer programs; the Industry/University Cooperative Research Centers program; the Research in Undergraduate Institutions program; and Research Opportunity Awards.

- **Centers**. The Centers program enables academic institutions along with their non-academic partner institutions to integrate discovery, research resources, and learning on scales that are extensive enough to significantly impact important science and engineering fields and cross-disciplinary areas through large-scale organized efforts. The Centers program consists of programs that exploit opportunities in science, engineering, and technology in which the complexity of the research problems or the resources needed to solve them require the advantages of scope, scale, change, duration, equipment, facilities, and students that can only be provided by an academic research center. The Centers Program includes the Centers for Analysis and Synthesis, Chemical Bonding Centers, Engineering Research Centers, Materials Research Science and Engineering Centers, Nanoscale Science and Engineering Centers, Science and Technology Centers, and Science of Learning Centers.

- **Infrastructure and Instrumentation (I&I).** The I&I program reflects parts of NSF's mission directed at programs to '"strengthen scientific and engineering research potential" and "to support the development and use of computers and other scientific methods and technologies, primarily for research and education in the sciences and engineering." Five program elements comprise I&I: Digital Library, Major Research Instrumentation, Research Resources, Science Resources Statistics, and Shared Cyberinfrastruture.

BIOLOGICAL SCIENCES $633,000,000

The FY 2008 Budget Request for the Directorate for Biological Sciences (BIO) is $633.0 million, an increase of $25.15 million, or 4.1 percent, over the FY 2007 Request of $607.85 million.

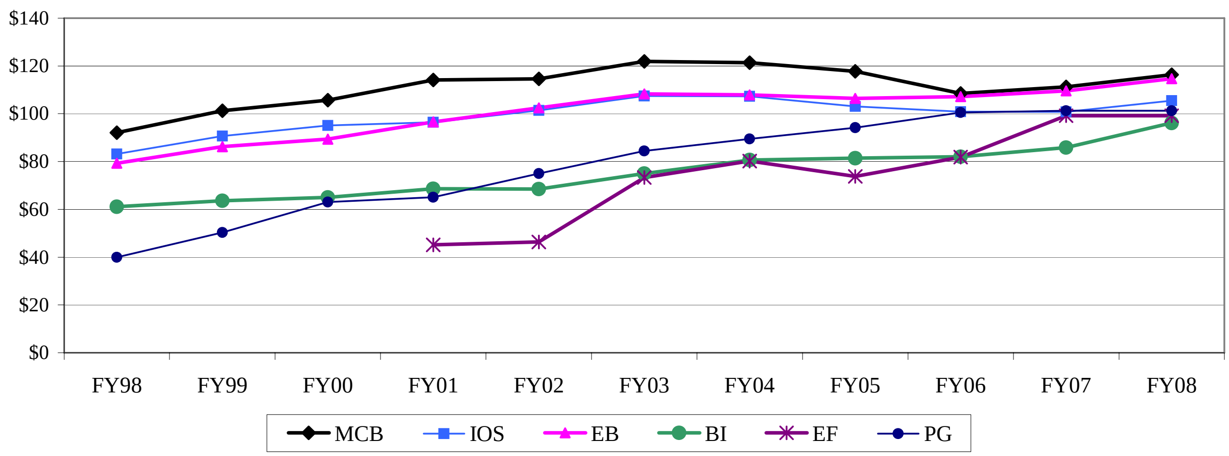
Biological Sciences Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Molecular and Cellular Biosciences (MCB)	$108.46	$111.22	$116.37	$5.15	4.6%
Integrative Organismal Systems (IOS)	100.83	100.74	105.49	4.75	4.7%
Environmental Biology (EB)	107.21	109.61	114.66	5.05	4.6%
Biological Infrastructure (BI)	82.02	85.90	96.10	10.20	11.9%
Emerging Frontiers (EF)	81.87	99.16	99.16	-	-
Plant Genome (PG)	100.51	101.22	101.22	-	-
Total, BIO	$580.90	$607.85	$633.00	$25.15	4.1%

Totals may not add due to rounding.

The Directorate for Biological Sciences 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. The BIO portfolio includes participation in NSF-wide and interagency research and educational activities, and emphasizes discovery, innovation, and learning aligned with the American Competitiveness Initiative (ACI) and NSF priorities. Research ranges from the study of the structure and dynamics of biological molecules, such as proteins and nucleic acids, through cells, organs and organisms, to studies of populations, ecosystems, and global change. It encompasses processes that are internal and external to the organism and includes temporal frameworks ranging from measurements in real time through individual life spans, to the full scope of evolutionary time. The explosion of biological information and the widespread application of biological concepts in other fields have led some to describe the 21st century as "The Age of Biology."

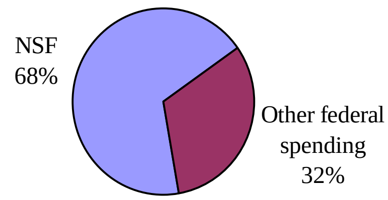
BIO Subactivity Funding
(Dollars in Millions)



RELEVANCE

NSF is the major source of federal funding for non-medical, fundamental biological research at academic institutions, providing 68 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.

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



BIO-supported research advances the frontiers of knowledge, increases our understanding of complex systems, and provides a theoretical basis for frontier research in many other scientific disciplines. Connecting knowledge about individual biological units into networks, from the molecular level to the global scale, is the challenge of the future in biology. Connecting these networks to each other to create a complex biological web of interactions can only be done in the context of all of the biological sub-disciplines working collaboratively with all other fields of science and engineering. The focus on multiple scales of biological organization builds on the current vigor of biological inquiry, but envisions a stronger conceptual basis to this inquiry to uncover basic principles. BIO is well-positioned to define and advance the theoretical and conceptual foundations of the life sciences well into the 21st century.

Biology is rich in theory that forms the foundation for advances in other sciences and engineering. Living organisms have evolved mechanisms for efficiently using energy, producing an endless array of novel compounds, and storing information in miniature, adaptable devices. Fundamental biological research can make this 3.5 billion years of biological innovation available to inform the next generation of nano-, bio-, and information technologies. Biological research leading to the development of novel sophisticated technologies to generate, store, and analyze genetic, cellular, organismal, and ecological data, will stimulate innovation in the physical sciences, engineering, and computer science, a primary goal of the Administration's American Competitiveness Initiative (ACI). For example, as noted in the ACI, harnessing the information stored in the genome requires basic discovery research to understand how that information is encoded. The discoveries at the fundamental level will provide new and important opportunities for the physical sciences and engineering to improve existing tools and develop new computational technologies that will help visualize these complex molecular systems. Similarly, the explosion of heterogeneous data for complex biological systems is providing a rich source of opportunities for developing innovative cyberinfrastructure and enabling breakthroughs in nanotechnology and biotechnology, areas highlighted in the ACI.

BIO is uniquely suited to advance our understanding of complex biological systems, in keeping with the Administration's FY 2008 R&D priorities, through its ability to integrate research across the entire range of biological systems and scales. Biological concepts are integral to wide-ranging areas of science, including national priorities such as nanotechnology, biotechnology, bioengineering, and climate change science. Mathematical modeling and computational simulations have become critical to cutting edge biology by allowing integration of knowledge on non-linear systems such as the biosphere, human social systems, the hydrologic cycle, and the built environment. BIO has made significant contributions to understanding the changing dynamics of the biosphere through investment in interdisciplinary knowledge across biology and sister fields. Continued investment will improve the capabilities for predicting a changing biosphere, and will foster development of broadly-testable theory that links the biosphere, geosphere, and atmosphere in a project like the National Ecological Observatory Network (NEON).

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

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

Enhanced support for disciplinary and interdisciplinary research across BIO's core programs is the highest priority in the FY 2008 Congressional Budget Request. BIO's funding profile continues to see drops in funding rates for research projects with a decrease to 14 percent in FY 2006. At a time when six of every seven proposals received are declined, enhanced attention to support of cutting edge science is necessary.

Molecular and Cellular Biosciences (MCB) +$5.15

Disciplinary and interdisciplinary research in the MCB core will increase to enhance support for research on living networks and complex molecular and cellular systems, microbial biology, and fundamental plant biology research.

Integrative Organismal Systems (IOS) +$4.75

Disciplinary and interdisciplinary research in the IOS core will increase to emphasize integrative research that focuses on understanding emergent properties of organisms that may be understood through interdisciplinary studies of behavioral, developmental, neural, physiological, and functional systems.

Environmental Biology (DEB) +$5.05

Disciplinary and interdisciplinary research in the DEB core will emphasize ecosystems and global change studies grounded in conceptual frameworks of ecology, phylogeny, and evolution; biodiversity research; and the emerging area of phylobiogeography.

Biological Infrastructure (DBI) +$10.20

Research Resources will increase to support development of tools for theoretical and systems biology research including instrumentation and cyberinfrastructure resources; and NEON development and planning. Human Resources will enhance support for activities to broaden participation in the biological sciences.

Emerging Frontiers (EF) $0.00

Two new activities will be established in EF in FY 2008 (+$8.0 million). Funding will begin at $5.0 million for a Plant Science Cyberinfrastructure Collaborative to enable new conceptual advances through integrative, computational thinking. A total of $3.0 million will support a multidisciplinary Center for Research on the Environmental and Health Safety of Nanotechnology to conduct fundamental research on the interactions between nanoparticles and materials and the living world at all scales. In addition, EF will provide venture funding for transformative research activities at the leading edge (+$10.54 million).

BIO-wide and NSF-wide investments will transition from EF to the core in FY 2008 (-$18.54 million). Broadening Participation programs will shift to the Division of Biological Infrastructure. Biocomplexity in the Environment and Mathematical Sciences will phase out completely as NSF-wide investments in FY 2008. However, components of each investment area – Coupled Natural and Human Systems (CNH) and Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences (UBM) – will be transferred to core programs for continued support.

Plant Genome Research Program (PGR) $0.00

Continued support for the interagency maize genome-sequencing project, genome-enabled research that addresses grand challenges in plant biology and takes full advantage of cyberinfrastructure and the latest systems biology approaches, and research collaborations with scientists in developing countries will receive the highest priority. Support will also be provided for the BIO-wide Arabidopsis ‘2010’ project.

Subtotal, Changes +$25.15

FY 2008 Request, BIO……………………………………………………………...……..$633.00

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

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

<u>Discovery Research for Innovation</u> +$14.20

Support for core BIO research will increase by $14.20 million. Increasing support for basic research in biology will enable the harnessing of 3.5 billion years of biological innovation for the next generation of nano-, bio-, and information technologies. Support of fundamental scientific discovery in biology will have major impacts on quality of life, technological innovation, economic competitiveness, and new job growth – high priorities of the President’s American Competitiveness Initiative (ACI). Focus of support will include: unlocking the genetic code; analysis within networks and across scales from cells to societies; theoretical and conceptual bases of biology; and changing dynamics of the biosphere.

A Plant Science Cyberinfrastructure Collaborative will enable new conceptual advances through integrative, computational thinking. With initial funding at $5.0 million, this collaborative will use new computer science, computational science, and cyberinfrastructure solutions to address grand challenges in biology. BIO’s investment in this critical activity will involve plant biologists, computer and information scientists, and experts from other disciplines working in integrated teams.

A multidisciplinary Center for Research on the Environmental and Health Safety of Nanotechnology, to be funded at $3.0 million, will conduct fundamental research on the interactions between nanoparticles and materials and the living world at all scales. Companion research on methods and instrumentation for nanoparticle detection, characterization and monitoring will occur. The fundamental research funded through this center will also support the regulatory mission agencies' abilities to develop science-based standards for risk assessments, such as the standards needed by the EPA to regulate products containing nanomaterials.

<u>Preparing the Workforce of the 21st Century</u> +$2.46

BIO will increase support for activities to broaden participation of individuals from underrepresented groups and for programs contributing to the ACI priority goal of enabling superior performance in STEM education by encouraging the best and brightest U.S. students to pursue careers in biology.

Transformational Facilities and Infrastructure +$7.49

An increase of $3.49 million will support development of tools for theoretical and systems biology research including instrumentation and cyberinfrastructure resources and enhance support for physical research resources used by the broad community of biological researchers.

Investment in the National Ecological Observatory Network (NEON) will increase by $4.0 million. The increase will be used to complete site deployment assessments and selection and to complete ongoing R&D projects on environmental sensors and networks, cyberinfrastructure for environmental observatories, and enabling technologies for ecological forecasting.

Stewardship +$1.00

BIO will increase support for administrative activities necessary to enable NSF to achieve its strategic goals. This includes the cost of Intergovernmental Personnel Act appointments and contractors performing administrative functions.

Subtotal, Changes +$25.15

FY 2008 Request, BIO……………………….……………………………………...…….$633.00

NSF-WIDE INVESTMENTS

BIO NSF-wide Investments
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Biocomplexity in the Environment	$30.43	$9.43	-	-$9.43	-100.0%
Climate Change Science Program	15.10	15.10	15.10	-	-
Cyberinfrastructure	84.00	90.50	95.50	5.00	5.5%
Human and Social Dynamics	0.50	0.50	0.50	-	-
International Polar Year	-	2.00	2.00	-	-
Mathematical Sciences	2.21	1.11	-	-1.11	-100.0%
National Nanotechnology Initiative	49.00	52.55	55.55	3.00	5.7%
Networking and Information Technology R&D	77.00	83.50	83.50	-	-

In FY 2008, the Directorate for Biological Sciences 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: With the conclusion of this priority area in FY 2007, two components of Biocomplexity in the Environment, Environmental Genomics and Coupled Natural and Human Systems, will be transferred to core programs for continued support. Support will continue within the EF activity for the Assembling the Tree of Life program. In addition, Ecology of Infectious Diseases, Microbial Genome Sequencing, and related activities that support Homeland Security and the

Administration's R&D priorities to develop an integrated, predictive modeling capability for emerging infectious diseases of plants, animals, and humans will continue in EF.

Climate Change Science Program: The Climate Change Science Program, a national research priority highlighted in OSTP/OMB Guidance, was established to respond to the challenge of understanding climate and climate variability. 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 some research activities in the Long Term Ecological Research (LTER) program.

Cyberinfrastructure: Improving high-end computing capability is an important objective of ACI and is expected to increase our understanding of complexity across biological systems by accelerating the pace and nature of biological discovery in the 21st century. A total of $95.50 million, or $5.0 million over the FY 2007 Request, 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 The *Arabidopsis* Information Resource (TAIR). New FY 2008 funds will provide $5.0 million of initial support for a new Plant Science Cyberinfrastructure Collaborative that will create intellectual synergy among biologists, computer and information scientists, mathematicians, engineers, and others to drive discovery and address the grand challenges in plant science.

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. HSD research examining the interactions of science and technology with political, economic, environmental, and educational systems will provide a better understanding of how social systems and their constituent parts react to drivers of change. This research directly relates to the ACI objective of strengthening economic competitiveness.

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. Support for research on the understanding of environmental change and biotic systems in the polar regions will continue in FY 2008.

Mathematical Sciences: With the conclusion of this priority area in FY 2007, key components of investment in Mathematical Sciences will be transferred to core programs for continued support. This includes support for the Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences (UBM) program.

National Nanotechnology Initiative: A total of $55.55 million includes support for research on biosystems at the nanoscale that exhibit novel properties. Potential applications of findings include exploiting functions of cellular organelles and nanoscale sensory systems, and the development of nano-devices for research in genomics, proteomics, cell biology, and nanoscale sensory systems. Continuing attention will be placed on research involving interdisciplinary research teams. FY 2008 funds will create a new, multidisciplinary Center for Research on the Environmental and Health Safety of Nanotechnology to conduct fundamental research on the interactions between nanoparticles and nanomaterials and the living world at all scales.

Networking and Information Technology R&D: A total of $83.50 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. These efforts are critical to the future of research technologies relevant to a broad range of scientific disciplines and are related to ACI priorities.

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 was allocated to projects that undergo external merit review was 97 percent in FY 2006, 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 (COVs), which are composed of 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. BIO convened a COV for the Division of Environmental Biology and a second one for the Emerging Frontiers activity in FY 2006.

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

The FY 2008 Budget Request is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals stated in the FY 2006-2011 Strategic Plan. These goals provide an overarching framework for progress in fundamental research and education and facilitate budget and performance integration.

Biological Sciences

By Strategic Outcome Goal

(Dollars in Millions)

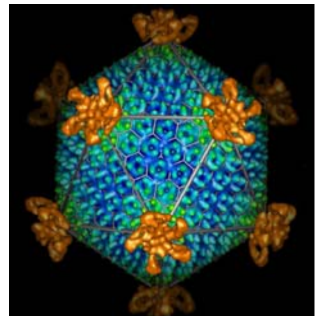
	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Discovery	$423.97	$433.58	$447.78	$14.20	3.3%
Learning	39.18	44.48	46.94	2.46	5.5%
Research Infrastructure	111.47	124.79	132.28	7.49	6.0%
Stewardship	6.28	5.00	6.00	1.00	20.0%
Total, BIO	$580.90	$607.85	$633.00	$25.15	4.1%

Totals may not add due to rounding.

BIO will continue its commitment to education, training, and increasing diversity while emphasizing the multidisciplinary, computationally sophisticated, complex systems oriented research that characterizes 21st Century Biology within all of its divisions and subactivities. The FY 2008 budget will slightly increase average award size and continue to focus on multidisciplinary research and interagency partnerships and activities, with special attention given to broadening participation at all levels.

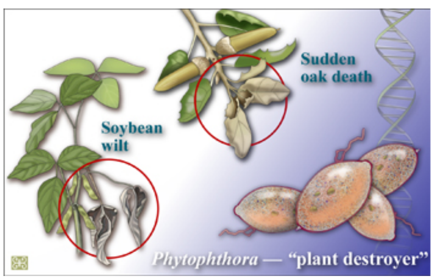
Recent Research Highlights

►**From Boiling Acid to Nanotechnology:** Newly discovered viruses isolated from microorganisms living in boiling acid pools in Yellowstone National Park are serving as raw materials for amazingly diverse new products, from nanoelectronics to drug delivery systems for cancer treatment. Mark Young and researchers at Montana State University isolated these viruses and studied their practically indestructible protein shells or "cages".



Structure of a virus from a boiling hot, acid pool in Yellowstone Park. Its protein coat is practically indestructible and is finding many uses. *Credit: Mark Young, Montana State University.*

They have now artificially replicated these cages for new applications in nanotechnology. They have used the cages as bases for new platinum catalysts to efficiently produce hydrogen and have made advanced magnetic materials for use in memory devices now in development by Panasonic. The researchers also established SpeciGen, a biotech company, which has exclusive rights to the patented protein cage technology. (MCB).

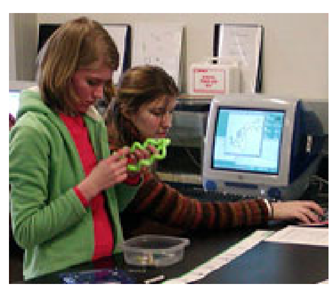


Scientists have sequenced the genomes from two species of the plant pathogen Phytophthora. *Credit: Zina Deretsky, National Science Foundation.*

► **Genome Info from "Plant Destroyers" Could Save Trees, Beans, and Chocolate:** An international team of scientists sequenced the first two genomes from a group of plant pathogens called *Phytophthora* – a name meaning "plant destroyer." *Phytophthora* are fungi-like but most fungicides can't kill them. More than 80 species of *Phytophthora* attack a broad range of plants and annually cost the agriculture, horticulture, forestry and nursery industries hundreds of billions of dollars.

Information gained from studying the genomes of *P. ramorum* and *P. sojae* will help scientists devise strategies to combat these and other disease-causing *Phytophthora*. *P. sojae* is responsible for $1-$2.0 billion in soybean losses worldwide each year. *P.ramorum* causes sudden oak death that has devastated the nursery industry and oak ecosystems in California, Oregon and Washington. More than one million native oak and tanoak trees have already died from the disease. The pathogen also destroys an estimated 450,000 tons of cocoa beans, resulting in a $400 million loss in chocolate production each year. (PGR).

► **High School Students Compete in Protein Modeling:** In 2005, for the first time, the Wisconsin Science Olympiad included a competition in protein modeling. The competitors used tools and data from the Protein Data Bank, an international repository for protein information, to develop physical models of two proteins and answer questions about each protein's structure, function and importance. Teams were scored on the accuracy of their models and their answers.



Wisconsin Science Olympiad contestants used the Protein Data Bank and modeling kits to examine the relationship between protein structure and function. *Credit: Center for Biomolecular Modeling.*

The event was conceived and organized by Gary Graper – a retired Madison West High School biology teacher – and the Center for BioMolecular Modeling at the Milwaukee School of Engineering. The success of the protein modeling event, one of 30 in the Olympiad, led to its proposal for inclusion in other state Science Olympiads in 2006 and in the national competition in 2007. (DBI).

►**Insight into Outbreaks:** Researchers and students at Auburn University and the University of Washington discovered important links between animal genetics, wildlife management, and an emerging infectious disease. Their research involved long-term observations of the eastern house finch, whose population suffered a severe conjunctivitis outbreak in 1993 that killed an estimated 100 million birds.

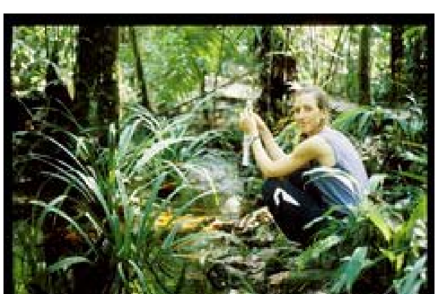
A female house finch suffering from conjunctivitis due to Mycoplasma gallicepticum infection. *Credit: Geoffrey E. Hill.*

In studying the finch's genome, the researchers uncovered a link between disease resistance and coloration: male finches with brilliant-red feathers recover more quickly from infection than those with more muted hues. Since Eastern house finches are also descendents of California house finches released by New York pet store owners in the 1940s, eastern populations have less genetic diversity than western populations. Comparing these two populations will not only help identify the specific genes involved in the finch's resistance to conjunctivitis but also elucidate how genetic diversity influences resistance. (EF).

►**Neuron Architecture and Brain Function:**
With hundreds of millions of neurons in the mammalian nervous system, neuroscientists often do research on less complex organisms – among them the roundworm *Caenorhabditis elegans* that has just 302 neurons. The neurons of both mammals and roundworms share many properties. Among them are a nucleus, common genes, and a common genetic code.

The transparent nematode, C. elegans, can be genetically engineered to visualize specific neurons using a fluorescent protein from jellyfish, thereby enabling studies into how neuronal cells connect and function in an intact living animal. *Credit: Kim Caldwell.*

Using *C. elegans* Guy Caldwell at the University of Alabama discovered a family of genes that control the position of the nucleus in the cell. He also found that when these genes are turned on, the nucleus shifts position impairing the ability of the neuron to communicate with other neurons. This discovery has implications for human neurological diseases. One of the earliest responses of neurons to injury or disease is movement of the nucleus to the edge of the cell. Understanding how and why such movements occur may suggest ways to prevent or reduce the devastating behavioral consequences of damage to the nervous system. (IOS).



Field assistant Bonnie Dickson collected dissolved carbon dioxide samples in a headwater stream of the Rio Cuerias, Brazil. *Credit: Anthony Aufdenkampe, Stroud Water Research Center.*

►**Amazon Breath – Not What You Expected:** During an extensive geochemical survey of the Amazon basin, NSF-funded scientists recently found that rivers in the region are "breathing" far harder - and cycling the greenhouse gas carbon dioxide far faster - than anyone realized.

Most of the carbon being exhaled as carbon dioxide from Amazonian rivers and wetlands has spent a mere five years sequestered in the trees, plants and soils of the surrounding landscape.

Until these data were collected, explained University of Washington oceanographer Emilio Mayorga, researchers had hoped that regions such as the nearly 2.4 million-square-mile Amazon River basin, where tropical forests rapidly gulp carbon dioxide during photosynthesis, were holding onto that carbon for decades or centuries. Since the five-year time scale is so much shorter than researchers had thought, the work adds important information to the global carbon cycle puzzle. (DEB).

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 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Senior Researchers	3,477	3,865	4,080
Other Professionals	1,604	1,783	1,882
Postdoctorates	1,314	1,461	1,542
Graduate Students	2,499	2,778	2,932
Undergraduate Students	3,288	3,655	3,858
K-12 Teachers	20	25	30
Total Number of People	12,202	13,567	14,324

BIO Funding Profile

	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Statistics for Competitive Awards:			
Number	1,200	1,334	1,408
Funding Rate	18%	19%	20%
Statistics for Research Grants:			
Number of Research Grants	803	892	941
Funding Rate	14%	13%	13%
Median Annualized Award Size	$140,000	$147,000	$147,000
Average Annualized Award Size	$190,670	$200,000	$207,000
Average Award Duration, in years	3	3	3

MOLECULAR AND CELLULAR BIOSCIENCES $116,370,000

The FY 2008 Budget Request for the Division of Molecular and Cellular Biosciences (MCB) is $116.37 million, an increase of $5.15 million, or 4.6 percent, over the FY 2007 Request of $111.22 million.

Molecular and Cellular Biosciences Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Molecular and Cellular Biology	**$108.46**	**$111.22**	**$116.37**	**$5.15**	**4.6%**
Major Components:					
Research & Education Projects	108.46	111.22	116.37	5.15	4.6%

About MCB:

MCB supports research to advance understanding of the fundamental properties and dynamics of biological molecules and cells. This research lays the groundwork for understanding multi-scale, complex, biological systems and their interactions with the physical world. Creative ideas and insights from MCB-supported investigators transform our understanding of the natural world. These advances contribute to our economy through discoveries pointing to new products and processes with applications in biotechnology, nanotechnology, and agriculture and contribute to our ability to detect and defend against biological threats.

Key biological questions include the nature and function of the molecular machinery of living cells, 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. Answering such complex biological questions increasingly requires the tools of genomics, the physical sciences, mathematics, computer and information science, and engineering, as well as integration of theoretical and experimental approaches.

MCB continues to forge partnerships to support research at the interfaces of these complementary disciplines, to introduce new analytical and conceptual tools for biological research, and to provide unique education and training opportunities for the next generation of researchers, scientific educators, and scientifically literate citizens. Leading edge cyberinfrastructure is indispensable for capturing, storing, manipulating, and analyzing the amounts and diversity of data that are enabling scientists and their students to meet these challenges.

The Molecular and Cellular Biosciences Division supports multidisciplinary research through three scientifically-focused clusters: **Biomolecular Systems**, **Cellular Systems**, and **Genes and Genome Systems**. Within the **Biomolecular Systems** cluster, the use of cutting-edge technologies is a priority to integrate theoretical, computational, and experimental approaches to study biological molecules and their functional complexes (paradigms for nanomachines). Nanoscale studies of the structure, function, and assembly of cellular elements are a priority for the **Cellular Systems** cluster, as is research on cellular mechanisms underlying immune-like defense mechanisms in plants and diverse animals, particularly lower vertebrates and invertebrates. The **Genes and Genome Systems** cluster supports studies of genomes, genome dynamics, and genetic mechanisms in all types of organisms, including vertical and lateral transmission of heritable information, and the variety of processes that carry out and regulate expression of the information encoded in the genome.

In general, 30 percent of the MCB portfolio is available for new research grants. The remaining 70 percent is used primarily to fund continuing grants made in previous years.

MCB priorities for FY 2008:

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 systems of interacting and interdependent networks. MCB will give priority to theoretical, computational, mathematical modeling and simulation approaches for study of molecular and cellular systems. Formulating and testing physical and mathematical models of the structure and function of complex systems of molecules, biochemical pathways, and other exquisitely regulated cellular processes are among the greatest theoretical and computational challenges facing biology in the 21st century.

Microbial Biology: Microbes are both individual cells and components of populations and communities that play critical, though poorly understood roles in the lives of all plants, animals, and ecosystems. Analysis of microbial genomes has provided a key to discovery of new organisms and to appreciation of the diversity of their metabolic functions that enable them to occupy diverse habitats and to interact in complex communities. Undiscovered microbes also represent rich resources of novel products and processes for applications in biotechnology, nanotechnology, and agriculture that will increasingly contribute to U.S. competitiveness. Support for research on microbes at all levels of biological organization is encouraged through the core activities as well as special activities for microbial observatories and microbial interactions and processes NSF programs that support the study of microbes are coordinated with activities of other U.S. government agencies through an interagency working group known as “The Microbe Project.”

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

Integration of education and broadening participation in all aspects of molecular and cellular research: These priorities contribute to U.S. competitiveness by making 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.

Fundamental 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 innovative projects integrate research and education.

Changes from FY 2007:

- Disciplinary and interdisciplinary research and education supported in the MCB core will increase by $5.15 million.

INTEGRATIVE ORGANISMAL SYSTEMS $105,490,000

The FY 2008 Budget Request for the Division of Integrative Organismal Systems (IOS) is $105.49 million, an increase of $4.75 million, or 4.7 percent, over the FY 2007 Request of $100.74 million.

Integrative Organismal Systems Funding

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Integrative Organismal Systems	**$100.83**	**$100.74**	**$105.49**	**$4.75**	**4.7%**
Major Components:					
Research & Education Projects	96.93	100.74	105.49	4.75	4.7%
Center for Behavioral Neuroscience[1]	3.90	-	-	-	N/A

[1] Moved to EF in FY 2007.

About IOS:

Biology, in the context of the organism, addresses questions that cannot be answered by focusing on the extremes of molecules or ecosystems. Innovations in genomics, molecular biology, and computer science are now enabling advancement of the frontiers of knowledge on an array of complex questions. The Division of Integrative Organismal Systems (IOS) supports research aimed at a comprehensive understanding of organisms. The goal is to predict why organisms are structured the way they are and function as they do with a particular emphasis on emergent properties of organisms, e.g.: **Complexity -** how interwoven organismal components or processes produce more than a sum of their parts; **Robustness -** the degree to which an organism resists perturbation or stressful influences; **Communication -** the processes that enable individual components in a system to instruct one another or alter one another's behavior; **Resilience** – the ability to recover from perturbation or stress; **Adaptability** – the capacity of organisms to change in response to perturbations in ways that maintain overall organismal integrity; and **Cooperation** – the behaviors of cells or organisms that benefit more than an individual.

Understanding these emergent systems properties of organisms requires integrative, interdisciplinary approaches and 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. These emergent properties can be understood through studies of the evolution, development, behavior, regulatory processes and structural properties of all organisms thus promoting comparative studies and the use of a wide variety of organisms as models.

The focus of IOS on emergent properties of organisms stems from the recognition that advancing our understanding of living systems cannot be achieved merely by enumerating and describing their individual components. IOS researchers are now advancing the frontier of understanding complex, dynamic organismal systems in their natural 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, environmental clean up, 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. Finally, advancing our understanding of how emergent properties arise in organisms may ultimately lead to a paradigm shift in the design, engineering, and production of biomimetic materials and machines, such as highly maneuverable, advanced aircraft.

In general, 39 percent of the IOS portfolio is available for new research grants. The remaining 61 percent is used primarily to fund continuing grants made in previous years.

IOS Priorities for FY 2008:

IOS will place highest priority on highly creative, integrative, and transformative studies that lead to a deeper understanding of the emergent properties of organisms. These properties such as complexity, robustness, communication, resilience, adaptability, and cooperation may begin to be understood through interdisciplinary studies of behavioral, developmental, neural, physiological, and functional systems and how they are integrated to produce living organisms. Studies that cross previously disparate scientific areas and that cross scales of organization from molecules to ecosystems involving a variety of levels of analysis will be highlighted.

Changes from FY 2007:

- Disciplinary and interdisciplinary research in the IOS core will increase by $4.75 million to support highly innovative studies that promise to provide a deeper understanding of the properties emerging from the interactions of the myriad of processes, and structures of living systems.

- The Division name was changed from Integrative Organismal Biology to Integrative Organismal Systems to reflect an enhanced focus on understanding emergent properties of living systems.

ENVIRONMENTAL BIOLOGY $114,660,000

The FY 2008 Budget Request for the Division of Environmental Biology (DEB) is $114.66 million, an increase of $5.05 million, or 4.6 percent, over the FY 2007 Request of $109.61 million.

Environmental Biology Funding

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Environmental Biology	**$107.21**	**$109.61**	**$114.66**	**$5.05**	**4.6%**
Major Components:					
Research & Education Projects	103.76	109.61	114.66	5.05	4.6%
National Center for Ecological Analysis and Synthesis[1]	3.45	-	-	-	N/A

[1] Moved to EF in FY 2007.

About DEB:

The Division of Environmental Biology supports catalytic and transformative research to inventory the diversity of life on earth, to discover its origins and evolutionary history, and to understand the dynamics of ecological systems. This research informs our ability to live sustainably on earth, since ecological systems provide the goods and services upon which human health and welfare depend (e.g., clean water, food and fiber, crop pollination, disease control). Fundamental research on the complex ecological and evolutionary dynamics inherent in environmental systems is crucial to maintaining a vital economy. It improves our ability to forecast environmental change and illuminates options for sustaining and improving ecological systems and related goods and services.

The explosion of biological information and the widespread application of biological concepts in other scientific disciplines is a consequence of both technological and theoretical advances. In Environmental Biology, two fundamental theories define the frontiers of inquiry: 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. Advancing both quantitative models and general theory remains a priority for DEB in order to further a predictive capability to address phenomena that occur at scales different from those at which measurements can be made, and to link structure and function in environmental systems.

DEB will continue to balance disciplinary and interdisciplinary needs that NSF supports uniquely or especially well, and foster synthesis and education in environmental biology while promoting full participation of all groups. Scientific foci in DEB address the processes of evolution; describe the genealogical relationships of all life; elucidate the spatial and temporal dynamics of species interactions that govern the assembly of functional communities; and determine the flux of energy and materials through ecosystems. This basic research in ecology, evolution and biodiversity is continually transformed as it incorporates new approaches and tools from genomics, computer, and mathematical sciences.

Research on biodiversity and phylogenetic relationships is time-critical due to the continuing loss of biodiversity. Such research provides a foundation for all environmental biology, serves sister fields such as physiology, neuroscience, conservation, restoration, and disease biology. In addition, phylogenetic frameworks may provide a predictive understanding of genetic potential and risk, with clear linkages to economically-important processes and products.

DEB also supports the Long-Term Ecological Research (LTER) program, a network of 26 research sites representative of the global range of natural, agricultural, and urban ecosystems. A Network Office coordinates cross-site communication, 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 and interdisciplinary activities. A two-year strategic planning exercise has highlighted opportunities for leveraging the network to understand ecosystems as coupled human-natural systems.

In general, 35 percent of the DEB portfolio is available for new research grants. The remaining 65 percent is used primarily to fund continuing grants made in previous years.

DEB priorities for FY 2008:

Understanding environmental change requires comprehension of the ecological and evolutionary mechanisms that sustain ecosystem functions. This requires research that is grounded in conceptual frameworks of ecology, phylogeny, and evolution. In FY 2008, DEB will support activities that: advance theory; address the couplings of systems across different time and space scales, and between human and natural systems; and consider feedbacks between evolutionary and ecological processes.

Characterizing the diversity of life on earth remains a key objective, as does placing this information in the context of a predictive understanding of evolution. In FY 2008, DEB will continue to support biodiversity research through the Planetary Biodiversity competition. Special emphasis will also be given to projects that create new cyberinfrastructure capabilities including continued investment in the LTER network.

Knowledge developed through core support of systematic biology has opened new research frontiers in ecology and evolutionary biology. In FY 2008, DEB will promote this transformational research through enhanced support for the emerging area of phylobiogeography.

DEB will continue to support outstanding projects that integrate education with research. Support will emphasize broad career horizons, experiential learning, and preparing people to understand and apply information about the biological world in their daily lives. DEB will support CAREER grants, Doctoral Dissertation Improvement Grants, and Research Experiences for Undergraduates, and maintain funding for the LTER Schoolyard Science activity to engage students in primary and secondary schools.

Changes from FY 2007:

- Disciplinary and interdisciplinary research in the DEB core will increase by $5.05 million.

BIOLOGICAL INFRASTRUCTURE $96,100,000

The FY 2008 Budget Request for the Division of Biological Infrastructure (DBI) is $96.10 million, an increase of $10.20 million, or 11.9 percent, over the FY 2007 Request of $85.90 million.

Biological Infrastructure Funding

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Research Resources	51.28	53.58	61.32	7.74	14.4%
Human Resources	30.74	32.32	34.78	2.46	7.6%
Biological Infrastructure	**$82.02**	**$85.90**	**$96.10**	**$10.20**	**11.9%**
Major Components:					
Research & Education Projects	74.90	78.77	84.97	6.20	7.9%
Facilities					
National Nanotechnology Infrastructure Network	0.40	0.40	0.40	-	-
National Ecological Observatories Network	5.93	5.94	9.94	4.00	67.3%
Cornell High Energy Synchrotron Source	0.79	0.79	0.79	-	-

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 under the purview of the Directorate for Biological Sciences.

DBI is organized into two clusters. The **Research Resources** cluster supports development of research tools and resources, including informatics tools to provide power to mine all available information, data/biological research resources to be utilized for new insights and discoveries, and instrumentation resources to provide access to the latest instrumentation with new capabilities. In addition, this cluster supports planning for the proposed National Ecological Observatories Network (NEON), 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"). This cluster focuses on integration of research and education, and works closely with the Education and Human Resource Directorate.

The DBI portfolio includes fellowships, instrumentation, and databases, and research grants. Approximately 49% is available for all new awards each year while approximately 23 percent of the DBI portfolio is available for new research grants. The remainder is distributed through grants for various DBI priorities and continuing funding for grants made in previous years.

DBI Priorities for FY 2008:

Research Resources

Cyberinfrastructure has been an integral part of all DBI activities and will continue to be a high priority for FY 2008. This cluster currently supports the following activities:

- Instrumentation Resources supports: (1) Instrument Development for Biological Research (IDBR); and (2) Improvement of Field Stations and Marine Laboratories (FSML). Also, BIO participation in MRI is managed within this subactivity.
- Biological Databases and Informatics supports the design, development, implementation, and use of information resources and tools.
- Biological Research Collections (BRC) supports natural history collections archived at museums, botanical gardens, field stations, and academic institutions that are widely used for biological research and education.
- Living Stock Collections (LSC) supports repositories of research organisms, genetic stocks, seeds, cell lines, and DNA clones that are associated with whole organisms in a collection.
- The *Arabidopsis* 2010 Project is a BIO-wide activity. DBI supports those 2010 projects that build community research resources that are necessary for integrative and systems biology research.
- National Ecological Observatories Network (NEON): Planning activities continue for NEON, a continental-scale research instrument consisting of geographically distributed infrastructure, networked via state-of-the-art communications. Additional detail on NEON can be found in the MREFC chapter.

Human Resources

Broadening participation, and integration of research and education are the two top priorities in DBI. Also, international experiences for participating students and postdocs are especially encouraged.

- Postdoctoral Research Fellowships: In FY 2008, BIO will support Minority Postdoctoral Research Fellowships, and the Theoretical and Computational Biology Research Fellowships.
- Undergraduate Research Mentoring in Biological Sciences (URM): This is an expanded version of the Undergraduate Mentoring in Environmental Biology (UMEB) program. The goal is to provide year-round mentoring in research in any area of biological sciences for undergraduate students, especially those from underrepresented groups.
- Support for Research Experiences for Undergraduate Sites (REU) continues to be a high priority. DBI partners with MPS, ENG, and SBE in supporting increasingly interdisciplinary REU site awards.
- This cluster manages BIO participation of the NSF-wide human resource activities including GK-12 and IGERT.

Changes from FY 2007:

- Research Resources will increase by $3.49 million. The increase will support development of tools for theoretical and systems biology research including instrumentation and cyberinfrastructure resources.
- Investment in NEON will increase by $4.0 million. The increase will complete key infrastructure such as cybernetworks and sensors, as well as continued environmental assessments necessary as BIO begins construction of NEON.
- As with all of BIO's core divisions, DBI will increase by $250,000 to support administrative activities necessary to enable NSF to achieve its strategic goals.
- Human Resources will increase by $2.46 million to support BIO's broadening participation activities including the Research Initiation Grants/Career Advancement Awards activity.

EMERGING FRONTIERS $99,160,000

The FY 2008 Budget Request for the Emerging Frontiers (EF) Subactivity is $99.16 million, which is equal to the FY 2007 Request of $99.16 million.

Emerging Frontiers Funding

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Emerging Frontiers	**$81.87**	**$99.16**	**$99.16**	**-**	**-**
Major Components:					
Research & Education Projects	78.92	78.85	70.85	-8.00	-10.1%
Centers Programs					
National Evolutionary Synthesis Center	2.95	3.00	3.00	-	-
National Center for Ecological Analysis and Synthesis[1]	-	3.46	3.46	-	-
Plant Science Cyberinfrastructure Collaborative	-	-	5.00	5.00	N/A
Center for Research on the Environmental and Health Safety of Nanotechnology	-	-	3.00	3.00	N/A
Center for Behavioral Neuroscience[2]	-	3.85	3.85	-	-
Center for Microbial Oceanography	-	4.00	4.00	-	-
Facilities					
National Ecological Observatories Network	-	6.00	6.00	-	-

[1] Funded in prior years in DEB. [2] Funded in prior years in IOS.

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 Ecology of Infectious Diseases and Microbial Genome Sequencing.

Centers offer the research community an effective mechanism to undertake long-term scientific research and education activities, to explore better and more effective ways to educate students, and to develop mechanisms to ensure the timely transition of research and education advances made into service in society. Centralization of management of all BIO-funded centers in EF fosters collaboration and integration of research themes, promotes cross-center interaction and learning, and facilitates the sharing of best practices between centers and NSF center managers.

In general, 57 percent of the EF portfolio is available for new research grants. The remaining 43 percent is used primarily to fund continuing grants made in previous years.

EF priorities for FY 2008:

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: This continuing research activity focuses 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.

Plant Science Cyberinfrastructure Collaborative: As enormous amounts of genomic data have flooded cyberspace, the need for additional centers for analysis and synthesis within biology, with a focus on this genomics data, has become critical. BIO proposes to create a center that will enable new conceptual advances by using new computer, computational science, and cyberinfrastructure solutions to address an evolving array of grand challenge questions in plant science. The central resources of the Collaborative will be computational and cyberinfrastructure capabilities and expertise capable of handling large and heterogeneous plant biology data sets. The Collaborative will be community-driven, involving plant biologists, computer and information scientists, and experts from other disciplines working in integrative teams. Resident social scientists will assess how the members of the Collaborative are interacting and using Collaborative resources.

Center for Research on the Environmental and Health Safety of Nanotechnology: Past experience with agro-biotechnology shows that the commercial exploitation of nanotechnology's vast potential can only succeed if credible information exists on the environmental and health safety aspects of this technology. NSF proposes to create a multidisciplinary center to conduct fundamental research on the interactions between nanoparticles and materials and the living world at all scales. This could include interactions of nanomaterials with cellular constituents, metabolic networks and living tissues, bioaccumulation and its effects on living systems, and the impacts of nanostructures dispersed in the environment on physico-chemical-biological processes and dynamics. Companion research on methods and instrumentation for nanoparticle detection, characterization, and monitoring will occur. The fundamental research funded through this center will also support the regulatory mission agencies' abilities to develop science-based standards for risk assessments, such as the standards needed by the EPA to regulate nanomaterials-containing products that are advertised as anti-microbial.

Changes from FY 2007:

- Funding for two NSF-wide investment areas, Biocomplexity in the Environment and Mathematical Sciences, is being transferred to core activities. Funding for special activities to broaden participation has been transferred to DBI, including the Research Initiation Grants/Career Advancement Awards (RIG/CAA) activity. (-$18.54 million)
- EF will provide venture funding for transformative research activities at the leading edge. (+$10.54 million)
- Centers: Creation of a Center for Research on the Environmental and Health Safety of Nanotechnology to conduct fundamental research on the interactions between nanoparticles and materials and the living world at all scales. Creation of a Plant Science Cyberinfrastructure Collaborative to use advanced computational and cyberinfrastructure capabilities and expertise to craft solutions to an evolving array of grand challenge questions in plant science. (+$8.0 million)

PLANT GENOME RESEARCH $101,220,000

The FY 2008 Budget Request for the Plant Genome Research (PGR) Subactivity is $101.22 million, which is equal to the FY 2007 Request of $101.22 million.

Plant Genome Research Funding

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Plant Genome Research	**$100.51**	**$101.22**	**$101.22**	**-**	**-**
Major Components:					
Research & Education Projects	100.51	101.22	101.22	-	-

About PGR:

The Plant Genome Research (PGR) subactivity was initiated in FY 1998, as part of the National Plant Genome Initiative (NPGI). Other participating agencies include United States Department of Agriculture (USDA), Department of Energy (DOE), United States Agency for International Development (USAID), U.S. Forest Service (USFS), and National Institutes of Health (NIH). The NSF program follows the guidelines and objectives of the National Plant Genome Initiative (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 Office of Science and Technology Policy (OSTP). NSF, DOE, and USDA often support joint activities, such as the Maize Genome Sequencing project and Gramene, an integrated database for cereals.

The ultimate goal of the NPGI is to understand the structure and function of all plant genes at levels from molecules to organisms and to ecosystems. New knowledge and insights gained from plant genomics will lead to unexpected discoveries and conceptual advances in our understanding of the biology of plants specifically and biology in general.

Basic 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 biology;
- Transformed plant biology into a 21st Century science;
- Contributed new discoveries that have formed a basis for the development of improved crop plants and new uses of plants;
- Revitalized plant sciences at U.S. colleges and universities;
- Attracted a new generation of students to plant biology research;
- Catalyzed large multinational collaborative plant genome research projects.

PGR currently supports the following specific activities:
- *Arabidopsis* 2010 Project;

- Comparative genomics;
- Research translating findings from model systems to economically important plants;
- Research addressing grand challenges in plant biology;
- Maize genome sequencing (Jointly with DOE and USDA);
- Community databases in coordination with USDA;
- High throughput methods/techniques/technology for plant biology research;
- Developing country collaboration in plant biotechnology;
- Broadening participation, education, training, and outreach.

In general, 36 percent of the PGR portfolio is available for new research grants. The remaining 64 percent is used primarily to fund continuing grants made in previous years.

PGR priorities for FY 2008:

Scientists have become increasingly able to answer long-standing major questions in biology because of the new tools and information resulting from PGR activities over the past 9 years. Genome-enabled plant biology research that takes full advantage of cyberinfrastructure and the latest systems biology approaches will be a high priority. A closer coordination with DOE, USDA, and USFS is expected in the area of research addressing the non-food use of plants such as biofuels and biomaterials.

Continue Support for Maize Genome Sequencing: PGR will contribute the third and last increment in support of the interagency maize genome-sequencing project that began in FY 2005. Maize is the most economically important crop in the U.S. When completed, the maize genome will become the most complex eukaryotic genome to be sequenced to date, including the human genome.

Continue Support for Genome-enabled Plant Biology Research: Building on the knowledge and research resources/tools accumulated over the last nine years, scientists are poised to tackle grand challenges in plant biology, as defined by the plant science community.

Research Collaborations with Scientists in Developing Countries: PGR will continue to support research collaborations between U.S. scientists and scientists in developing countries with a focus on plant genomics and plant biotechnology. The activity 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. To date, PGR has supported research collaborations with scientists from Bolivia, Brazil, Colombia, India, Indonesia, Mexico, Nepal, Nigeria, Peru, Philippines, South Africa, and Sri Lanka.

COMPUTER AND INFORMATION SCIENCE AND ENGINEERING $574,000,000

The FY 2008 Budget Request for the Computer and Information Science and Engineering (CISE) Directorate is $574.00 million, an increase of $47.31 million, or 9.0 percent, over the FY 2007 Request of $526.69 million.

Computer and Information Science and Engineering Funding

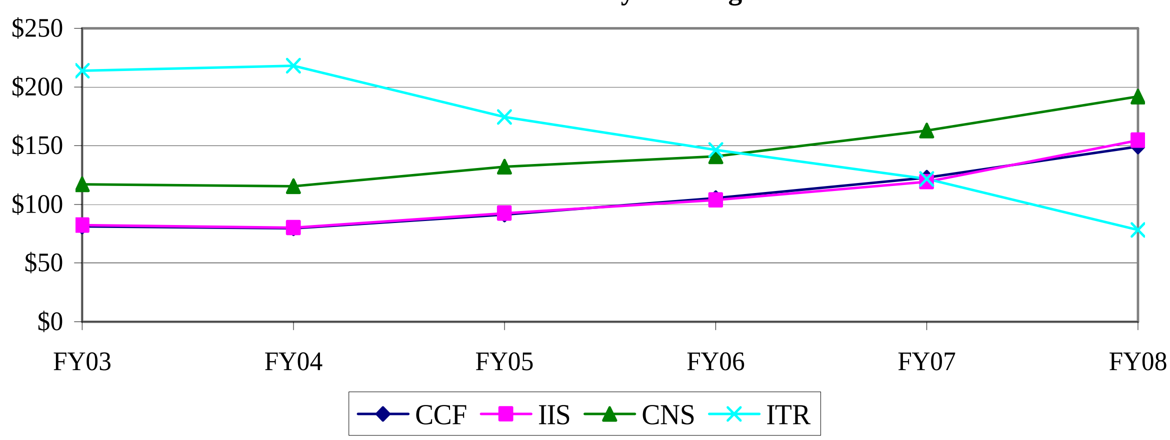
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Computing and Communication Foundations (CCF)	$105.30	$122.82	$149.15	$26.33	21.4%
Computer and Network Systems (CNS)	141.07	162.98	191.98	29.00	17.8%
Information and Intelligent Systems (IIS)	103.78	119.30	154.63	35.33	29.6%
Information Technology Research (ITR)	146.20	121.59	78.24	-43.35	-35.7%
Total, CISE	$496.35	$526.69	$574.00	$47.31	9.0%

Totals may not add due to rounding.

The mission of the CISE Directorate is to enable the U.S. to uphold a position of world leadership in computer, communications, and information science and engineering; to promote understanding of the principles and uses of advanced computer, communications, and information systems in service to society; and to contribute to universal, transparent, and affordable participation in an information-based society. CISE supports investigator-initiated research in computer science and engineering and related fields, contributes to the education and training of computing professionals and, more broadly, prepares a workforce with the computing competencies essential to success in an increasingly competitive global market.

CISE Subactivity Funding



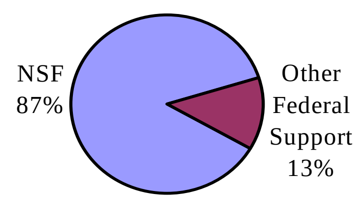
Note: The chart indicates that, with the completion of the ITR priority area in FY 2004, CISE ITR investments are being redirected to prominent IT research challenges and opportunities in core CISE activities in CCF, CNS, and IIS.

The CISE Directorate is in a unique position to help realize the goals and objectives outlined in the American Competitiveness Initiative (ACI). CISE research and education outcomes are vital to the Nation's economic future in two important ways: through the economic robustness the IT industry itself generates and through IT-enabled discovery and innovation across all sectors of the economy, including healthcare, manufacturing, and many other enterprises.

RELEVANCE

NSF is the principal source of federal funding for university-based basic research in computer science, providing the vast majority – 87 percent – of total federal support in this area. In recent years, the fruits of basic research investments in computer science and engineering – information technology (IT) – have provided unsurpassed value to the U.S. economy. As the President's Council of Advisors in Science and Technology (PCAST) recently noted, IT has served both *as the basis for innovation and economic growth, and as a technology enabler for increased productivity that provides an additional avenue of economic benefit to the Nation across a wide range of sectors*.

Federal Support for Basic Research in Computer Science at Academic Institutions



Essentially all practical applications of IT are based on ideas and concepts that emerged from basic research investments – often made many years before – in computer science and engineering. These fundamental ideas and concepts have enabled innovative product and application developments that now permeate all areas of modern life. IT not only forms a sizeable portion of the economy in its own right, but drives discovery and innovation in many other areas, including advanced scientific research, healthcare, national and homeland security, organizational effectiveness, and governmental efficiency. Innovation in IT will remain an essential and vital force in productivity gains and economic growth for many years to come, positioning CISE as a central and essential actor in realizing the goals of the American Competitiveness Initiative.

The CISE Directorate continues to play a leadership role in the multi-agency Subcommittee on Networking and Information Technology Research and Development (NITRD), which is co-chaired by the Assistant Director of NSF for CISE. Consistent with the Administration's NITRD priority, in FY 2008 CISE will continue to advance the computing frontier, stimulating research advances in new computing software, hardware, systems, and algorithms. CISE will continue to increase investments in networking and distributed systems to address issues of security, reliability, and integration of new technologies that prevent the full exploitation of the current Internet and related technologies. CISE also will support fundamental research in new hardware and software architectures for high performance computing (HPC) in support of NSF's cyberinfrastructure vision. The Administration's Homeland Security priority will be addressed with investments in areas such as cybersecurity, machine translation, artificial intelligence, computer vision, and technologies for collaboration and information retrieval. CISE will contribute to the National Nanotechnology Initiative via exploratory and interdisciplinary work on novel nano-based devices and architectures that promise to form the basis of future computing and communication systems.

As a result of the increasingly important 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 2007, a success rate of 21 percent or less is projected.

NSF is the principal source of federal support for strengthening STEM education across all levels and is uniquely positioned to lead the Nation in STEM education due to its focus on STEM education research. CISE's education programs are responsive to the directorate's mission and goals, increase American competitiveness in the global economy, and support NSF's underlying strategy of integration of research and education.

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

FY 2007 Request, CISE……………………………………………………………………….$526.69

Computing and Communication Foundations (CCF) +$26.33

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 improved security, reliability, and manageability of computing systems; and support the 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 (CNS) +$29.00

Increased funding 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. Using GENI, researchers will be able to explore a "clean-slate" reinvention of the Internet to build in security and robustness and to create 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. 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.

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 (IIS) +$35.33

Increased support will target the development of transformative projects that tackle the challenges of creating comprehensively intelligent systems that master and integrate multiple cognitive tasks. The new visions for reliable and secure distributed computer networks targeted by GENI must be developed in lockstep with new visions for the future-generation in formation systems what will live on them. IIS will support research on next-generation networked information systems, tackling such questions as: What will information systems looks like when they reside in new generations of networks with nodes of greatly heterogeneous capability, mobility, and use? How can information be provided not only based on content but also context? IIS will build research capacity in areas foundational to homeland security such as machine translation, artificial intelligence, computer vision, and robotics.

Information Technology Research (ITR) -$43.35

Funds are redirected to prominent IT research challenges and emerging scientific opportunities in CCF, CNS, and IIS. For example, redirected funds will be used to support research on Cyber Trust and to support the broader category of cybersecurity research. ITR funds will also be used to increase core funding rates in the core CISE disciplines.

Remaining ITR funds will support new research in computing fundamentals and research supporting larger, experimental projects that promise IT systems that are more reliable and robust, have better and more predictable performance, provide useful new services, and exploit the potential of emerging technologies.

Subtotal, Changes +$47.31

FY 2008 Request, CISE……………………………………………………………………………$574.00

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

FY 2007 Request, CISE………..…………………………………………………….…….……... $526.69

The CISE FY 2008 budget contributes directly to the goals of the American Competitiveness Initiative and to other Administration priorities including advanced networking and high-end computing. CISE will refocus its Discovery Research for Innovation portfolio to exploit emerging opportunities at the frontier. The directorate also will increase investment in the preparation of a U.S. workforce with the core computing skills essential to their effective participation in an increasingly competitive global environment. Finally, CISE is increasing investments in Transformational Facilities and Infrastructure, supporting the further design of a state-of-the-art networking facility, the Global Environment for Networking Innovations (GENI), that will provide new and unique basic research opportunities in networking and distributed systems while promising significant potential for shorter-term innovation.

<u>Discovery Research for Innovation</u> +$27.15

CISE will refocus its investments in high-risk, high-return computing research essential to innovation and economic competitiveness in IT. Just as research advances in IT have made unsurpassed contributions to the Nation's technological, economic, and security posture over the past ten years, so future CISE research investments are designed to both deepen and accelerate computing contributions to the Nation's competitive position.

- *Computing Fundamentals and Research (+$50.0 million).* At a level of $50.0 million, CISE will support new research in computing fundamentals and research supporting larger, experimental projects that promise IT systems that are more reliable and robust, have better and more predictable performance, provide useful new services, and exploit the potential of emerging technologies. CISE-funded research projects will also shed new light on the complex interdependencies of social and IT systems, focusing on those areas that have the potential to transform learning and discovery, contribute to U.S. competitiveness and ACI goals and objectives, and enhance the quality of life for all people.

- *Software Design and Productivity (+$10.0 million).* CISE will make new investments in software design and productivity at a level of $10.0 million. The focus will be on development of innovative theories, methods, and tools to address the limitations in the technologies developed over the last 50 years. New computational models for software will be incubated with focused funding and supportive demonstration environments. While much of the software development research in the first 50 years of computing was focused on correct syntax-directed computation of details for computer execution, future efforts will shift to semantics-directed computation of correct abstractions for human understanding and manipulation.

- *Cyber-enabled Discovery and Innovation (+$20.0 million).* Computing concepts, tools, and methodologies play a central role in NSF's new investment in Cyber-enabled Discovery and Innovation (CDI), and simultaneously contribute to the goals of the ACI. CISE will contribute 38 percent ($20.0 million) of the agency's overall investment of $51.98 million. CISE research investments will contribute in fundamental ways to all five CDI conceptual areas - knowledge extraction, interacting elements, computational experimentation, virtual environments, and education for computational discovery. CISE-supported CDI outcomes will deepen computational thinking in all fields supported by NSF, stimulating innovation across the science and engineering frontier.

- *CAREER (+$2.0 million).* CISE will provide an additional $2.0 million, for a total of $40 million in FY 2008, in support for the CAREER program to enhance opportunities for early career faculty.

- *Industry/ University Cooperative Research Centers (+$750,000).* Additional support of $750,000, for a total CISE contribution of $2.0 million, will be provided for Industry/ University Cooperative Research Centers (I/UCRCs). CISE-supported I/UCRCs contribute directly to the goals of the ACI by nurturing industry-university partnerships, thus speeding the transfer of basic research outcomes in computing into IT products and services.

- *Other Changes (-$55.60 million).* Increases in Discovery Research for Innovation discussed herein are offset mainly through conclusion of ITR program activities.

Preparing the Workforce of the 21st Century +$10.50

- *International Workforce (+$10.0 million).* Through a new internationally focused program funded at $10.0 million, CISE will contribute to the development of a competitive, globally aware workforce. This activity will foster international relationships and cooperative research and education activities that support CISE's mission and maximize the strategic value of its investments.

- *REU (+$500,000).* CISE will provide an additional $500,000, for a total of $4.0 million, in support for students through the Research Experiences for Undergraduates (REU) program.

<u>Transformational Facilities and Infrastructure</u> +$8.00

An additional $10.0 million, for a total of $20.0 million, will support pre-construction planning activities for the Global Environment for Networking Innovations (GENI). GENI will provide computing researchers with world-class experimental opportunities that will substantively transform research in networking, distributed systems, and eventually many other areas. The GENI facility is expected to increase the quality and quantity of experimental research outcomes supported by CISE and to accelerate the transition of these outcomes into products and services to enhance economic competitiveness and secure the Nation's future. As the GENI effort ramps up, other research resources efforts will be scaled back by $2.0 million in the short term to accommodate additional funding for GENI.

Subtotal, Changes +$47.31

FY 2008 Request, CISE……………………………………………………………………...…….$574.00

NSF-WIDE INVESTMENTS

In FY 2008, 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 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Biocomplexity In the Environment	$3.00	-	-	-	N/A
Cyber-enabled Discovery and Innovation	-	-	20.00	20.00	N/A
Cyberinfrastructure	64.37	68.00	87.00	19.00	27.9%
Human and Social Dynamics	3.02	5.00	2.00	-3.00	-60.0%
Mathematical Sciences	2.29	1.15	1.15	-	-
National Nanotechnology Initiative	10.42	12.87	11.00	-1.87	-14.5%
Networking and Information Technology R&D	496.35	526.69	574.00	47.31	9.0%

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

Cyber-enabled Discovery and Innovation: In FY 2008, CISE provides $20.0 million for the new CDI investment. CDI research aims to explore radically new concepts, approaches and tools at the intersection of computational and physical or biological worlds. CDI will provide the new concepts and tools that are needed to address the challenges posed by a world of petascale computers, massive data flows and databases, and an economy dependent on digitally enabled activity.

Cyberinfrastructure: A total of $87.0 million, an increase of $19.0 million, will support an increase in research on computing and communication techniques and systems that will be part of 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. Through increased support for GENI, CISE will provide computing researchers with world-class experimental opportunities that substantively transform research in networking, distributed systems, and other areas.

Human and Social Dynamics: A total of $2.0 million for 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: With the conclusion of this priority area in FY 2007, the FY 2008 funding reflects spending for continuing awards made in prior years. Other components of this investment will return to core programs for continued support.

National Nanotechnology Initiative: A total of $11.0 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 $574.0 million is included in NITRD activities supporting fundamental research and related education in information technology and networking.

QUALITY

CISE identifies the highest quality research 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 2006, 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 were convened for the CNS Division in March 2006 and for the CCF Division in June 2006.

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 2008 budget is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals stated in the FY 2006-2011 Strategic Plan. These goals provide an overarching framework for progress in fundamental research and education and facilitate budget and performance integration.

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

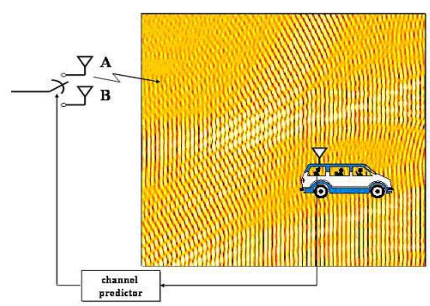
	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Discovery	$428.30	$452.97	$480.12	$27.15	6.0%
Learning	31.04	36.73	47.23	10.50	28.6%
Research Infrastructure	29.53	31.08	39.08	8.00	25.7%
Stewardship	7.48	5.91	7.57	1.66	28.1%
Total, CISE	$496.35	$526.69	$574.00	$47.31	9.0%

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 Learning 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 2008. At the same time, the FY 2008 Request seeks to optimize funding rates and to emphasize crosscutting research and education opportunities in computing.

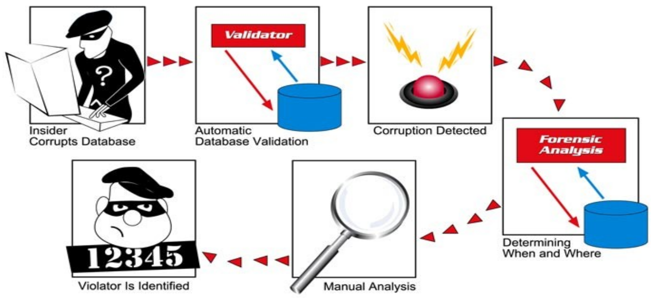
Recent Research Highlights

► **New tools improve quality of service for wireless customers:** Researchers at North Carolina State University have developed a suite of adaptive tools that can improve both the capacity and quality of wireless communication service. Since channels change rapidly in mobile radio communications, most transmitters and receivers today are not optimized for the channel conditions they encounter from instant to instant. Accordingly, the devices fail to exploit the full potential of the wireless channel. These new adaptive tools predict information about a fading wireless channel – information that allows more efficient use of power and frequency. By collaborating with an industry partner, the researchers were able to validate the tools using realistic modeling and field measurements. In 2005, more than one billion consumers worldwide owned and used wireless telephones – the majority of those users being in North America, Western Europe and the Asia-Pacific region. The tremendous growth in demand for wireless communication capacity has created a need for new transmission and receiving methods to enhance user quality of service. (CCF)



New wireless communication tools will improve the quality of service for consumers. *Credit: Alexandra Duel Hallen.*

► **Detection and Forensic Analysis of Database Tampering:** Computer scientists at the University of Arizona have developed new techniques to detect instances of unauthorized access and tampering with electronic databases – even when the intruders are insiders. Imagine, for example, that a corporate accountant splits a transaction, after the fact, into multiple transactions to hide the magnitude of a questionable action. Or imagine that an administrator at a medical facility changes the date of a confidentiality signature after learning that some personal health data had been revealed erroneously to a third party. Conventional defenses, which try to protect the data with software and hardware "fences," simply do not work in such situations: the intruders are already inside the fences. However, the newly created analysis techniques can identify these data manipulations. Moreover, they can provide a sophisticated forensic analysis of the crime, identifying when the corruption took place, verifying the original date of the corrupted data and indicating which data were changed. The techniques will also verify when large volumes of data in a database have not been corrupted. The payoff: an increase in people's trust in such systems. (IIS)



Researchers have developed new methods for detection and subsequent forensic analysis of database corruption. *Credit: Created by Cheryl Ryan and Richard T. Snodgrass, 2006*

► **New Wi-Fi Network Brings Eye Care to Thousands in India:** Thousands of villagers in India are receiving quality eye care for the first time, thanks to new technology for low-cost rural connectivity developed by NSF-funded researchers at the University of California Berkeley, and the Intel Research Berkeley lab. Based on "Wi-Fi" wireless networks, the new technology allows eye specialists to interview and examine patients in five remote clinics via a high-quality videoconference that uses simple, inexpensive software and hardware. The system provides villages with a high-bandwidth connection to computer networks in cities as far as 50 miles away. The researchers implemented the Technology and Infrastructure for Emerging Regions (TIER) pilot program in 2005. Because of the initial success, TIER will soon expand to include five hospitals linked to 50 clinics that will annually serve an expected half a million patients in the southern Indian state of Tamil Nadu. (IIS)

In this satellite map graphic of the Aravind network, green lines indicate links from the central hospital to rural vision centers in five rural towns. All distances are in kilometers. *Credit: Graphic by Sonesh Surana.*

► **Compressive Sampling Technique Promises Improved Healthcare Imaging:** In a finding by researchers at the California Institute of Technology that contradicts the conventional wisdom in their field, NSF-funded computer scientists have proved that it is possible to reconstruct a high-resolution digital image or signal using a comparably small number of measurements. The new theory, called Compressive Sampling (CS), could have widespread practical impact, with applications ranging from completely new data acquisition algorithms to dramatically new compression and error-correction schemes. In the field of medical imaging, for example, CS could enable new technologies such as high-speed magnetic resonance angiograms. In the field of communications, CS could help meet the growing challenge of processing wideband radio frequency signals. (CCF)

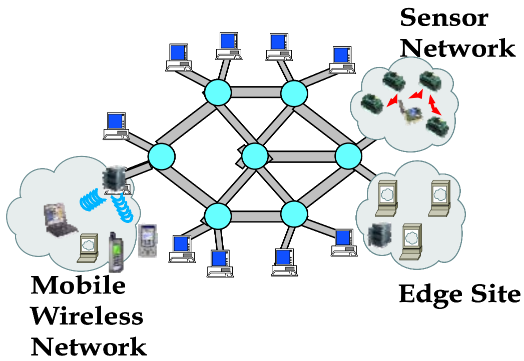
This image, from the game Unreal Tournament 2004, requires 6,768,766 depth comparisons. On average only 7.3 bits out of 32 bits are actually necessary to make the comparison. Our asynchronous comparison takes advantage of this possible optimization and operates 12 times more efficiently than conventional synchronous circuits. *Credit: Epic Games.*

► **Power-Thrifty Graphics Extend Battery Life:** The recent explosion in the number and type of handheld multimedia devices used by consumers, professionals and the military has created a need for energy-efficient computation to extend battery life. Recently, researchers at the University of North Carolina at Chapel Hill have demonstrated dramatic improvements in energy efficiency by devising computing methods that use a "compute-on-demand" strategy. Normally, a computer's microprocessor executes operations in prescribed, timed cycles, giving rise to the term "clock speed" as a measure of chip performance. In the new "clockless" approaches, computing tasks are no longer tied to the clock's cycle. Significant power is only used when there is work to be done; when there isn't, the device consumes practically no energy. The compute-on-demand, clockless method is more than 10 times more efficient than conventional, clocked systems. Resultant energy savings significantly extend battery life. (CCF)

► **Human Face Detection:** Researchers at Colorado State University (CSU) have developed a face detection and recognition algorithm, and have integrated it into a new real-time system. The new software is being prepared for release as part of a CSU face recognition software package. The current CSU Face Identification Evaluation System has been downloaded over 10,000 times by people from all over the world for use as a teaching and research tool. The release later this year of an open-source, real-time face recognition system will make the CSU software even more useful and appealing, particularly to students seeking hands on experience with a fully interactive face recognition system. (IIS)

Colorado State University's face detection and identification system is being prepared for release as part of their Evaluation of Face Recognition Algorithms package. The system both identifies and recognizes the individual in the foreground. *Credit: J. Ross Beveridge, Colorado State University, 2006*

► **Global Environment for Networking Innovations**: Last year three CISE-funded projects, Emulab, Planetlab, and DETER, provided thousands of researchers working on hundreds of research projects to experiment with large-scale distributed systems and networks. This suite of experimental platforms, used together or separately, have permitted CISE investigators to explore solutions to increase the stability and security of advanced networks and distributed systems. Use of these platforms is informing the research community's design of a larger-scale experimental facility with greatly increased functionality and versatility – a facility called GENI, the Global Environment for Networking Innovations that will support exploration of revolutionary systems architectures that will lead to reinvention of the "Internet" as it is known today. (CNS)



The goal of GENI research is to overcome the limitations of today's internet and create new network architecture for the 21st Century. *Credit: Computer and Network Systems Division, CISE, NSF*

Other Performance Indicators

The tables below show 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 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Senior Researchers	5,040	5,200	5,450
Other Professionals	706	720	750
Postdoctorates	285	295	310
Graduate Students	5,042	5,200	5,450
Undergraduate Students	731	750	790
Total Number of People	11,804	12,165	12,750

CISE Funding Profile

	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Statistics for Competitive Awards:			
Number	1,281	1,200	1,270
Funding Rate	26%	21%	24%
Statistics for Research Grants:			
Number of Research Grants	1,003	950	1,000
Funding Rate	22%	18%	20%
Median Annualized Award Size	$116,000	$116,000	$116,000
Average Annualized Award Size	$146,000	$158,000	$158,000
Average Award Duration, in years	3.0	3.0	3.0

COMPUTING AND COMMUNICATION FOUNDATIONS $149,150,000

The FY 2008 Budget Request for the Division of Computing and Communication Foundations (CCF) is $149.15 million, an increase of $26.33 million, or 21.4 percent, over the FY 2007 Request.

Computing and Communication Foundations Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Computing and Communication Foundations	**$105.30**	**$122.82**	**$149.15**	**$26.33**	**21.4%**
Major Components:					
Research & Education Grants	97.30	114.82	141.15	26.33	22.9%
Science and Technology Centers					
STC for Embedded Networked Systems	4.00	4.00	4.00	-	-
STC for Ubiquitous Secure Technology	4.00	4.00	4.00	-	-

About CCF:

CCF addresses current and emerging areas of computing and communication foundations: theory and incubation of computing and communication; processes and artifacts for computing and communication; signals, communication and interaction; and foundations of systems in use. Within and across these areas, 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 general, 58 percent of the CCF portfolio is available for new research grants. The remaining 42 percent is used primarily to fund continuing grants made in previous years.

Science and Technology Centers
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. CCF also supports the Science and Technology Center for Ubiquitous Secure Technology at the University of California at Berkeley (TRUST). TRUST is addressing 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.

CCF Priorities for FY 2008

Cyber-enabled Discovery and Innovation
In support of the American Competitiveness Initiative, CCF plans a large effort in Cyber-enabled Discovery and Innovation. Computation has revolutionized science, engineering, and daily life through massive computation, simulation, and other algorithmic processes. Computers are tools that provide new

ways of probing and shaping our world through simulation utilizing massive data capture. Computers are also tools for performing more abstract tasks, ranging from the automation of mathematical proof to the secure use of ecommerce, banking, and credit cards. Computer and information science now promises a second revolution through a new way of understanding nature and engineered artifacts. Cyber-enabled discovery, the use of algorithmic and computing insights to recast the core concepts of science and engineering, is at the heart of this revolution. These insights will increase our understanding of complex processes that arise in many fields of science and engineering. Examples are the mechanisms by which the cell processes proteins to generate other proteins, by which the neurons in the brain learn, or by which companies incorporate current prices and market behavior into their strategies. With better understanding, improvements in the products and processes that underlie American competitiveness will be realized.

Hardware and Software Frontier Areas
CCF support of American competitiveness is also exemplified by an emphasis on the architecture and software of computer systems. The multi-core chip architectures that are now appearing on the market are merely the first wave of chips that will eventually include hundreds or thousands of processors. The overall architecture of such large chips raises many new research questions, as does the design of software for them. In addition, a broad and diverse workforce must be prepared with skills in the design, programming, and use of multi-core processors. CCF will emphasize research and education in software frontier areas, such as software architectures, components, and dynamics. An enhanced ability to produce and design software-intensive systems will ensure American competitiveness.

Foundational Research in Visual Analytics
Visual approaches to understanding information extend beyond traditional computer graphics. These approaches are crucial to new scientific and engineering discovery and to the competitiveness and well being of the Nation. Foundational and applied research is needed into how humans learn from complex visual presentations, and how they sense, reason and respond to produce a seamless flow of hypothesis, evaluation and discovery. CCF will emphasize foundational research in this area of visual analytics.

Scientific Foundations for Internet's Next Generation
CCF will continue its emphasis on the Scientific Foundations for Internet's Next Generation (SING). This topic merges elements of the theoretical foundations of computing, communications, signal processing, and network science into a foundation for a clean-slate redesign of the Internet. This coordinates well with NSF's construction of the GENI facility. The resulting increase in connectivity will both increase American competitiveness and broaden participation in this enterprise to more sectors of our population.

Changes from FY 2007:
The FY 2008 request for CCF includes an increase of $26.33 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 consistent proposal funding rate.

COMPUTER AND NETWORK SYSTEMS $191,980,000

The FY 2008 Budget Request for the Division of Computer and Network Systems (CNS) is $191.98 million, an increase of $21.0 million, or 17.8 percent, over the FY 2007 Request of $162.98 million.

Computer and Network Systems Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Computer and Network Systems	**$141.07**	**$162.98**	**$191.98**	**$29.00**	**17.8%**
Major Components:					
Research & Education Grants	112.44	132.40	153.40	21.00	15.9%
Computing Research Resources	28.63	30.58	38.58	8.00	26.2%

About CNS:

The CNS Division addresses four areas: computer systems, network systems, computing research infrastructure, and education and workforce. Within and across these areas, CNS supports research and education activities related to the development of new computing and networking technologies and to the exploration of 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 development and use of computing research infrastructure, which 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 prepare future generations of computer science and engineering professionals.

In general, 47 percent of the CNS portfolio is available for new research grants. The remaining 53 percent is used primarily to fund continuing grants made in previous years.

CNS Priorities for FY 2008

The focus of the FY 2008 request for CNS is to initiate new and emerging research areas related to Cyber-enabled Discovery and Innovation, increase funding for the Global Environment for Networking Innovations (GENI) activity, and strengthen existing programs such as Computer Systems Research (CSR), Cyber Trust, CPATH, and Broadening Participation in Computing.

Cyber-enabled Discovery and Innovation

In support of the American Competitiveness Initiative, CNS will participate in Cyber-enabled Discovery and Innovation. High-performance, seamless, robust networks are essential to the conduct of cyber-enabled science and engineering to work. Research challenges include identification and mitigation of failures and performance issues, timely integration of new technology into the network infrastructure, and evaluation and development of next- and future-generation innovations.

Global Environment for Networking Innovations (*GENI)*
CNS support of American competitiveness is also exemplified through the continued support of the design of the GENI facility. Experiments on this facility will lead to a future Internet that meets the demands of the 21st century, including increased security, the use of large-scale, distributed societal applications, and the inclusion of wireless and sensor systems in end-to-end networking solutions. Research challenges and opportunities include: clean-slate thinking unconstrained by today's Internet; alternative protocols and architectures; and research on new applications and services running as overlays on top of today's network.

Computer Systems Research
Computer systems research will focus on: (1) distributed, mobile, and embedded systems; (2) sensing and control systems; (3) dynamically configured, multiple-component systems; and (4) parallel systems. The FY 2008 request will enable a focus on emerging areas, including cross-systems integration, virtualization for configuration and management, and cyber-physical systems.

Cybersecurity research will continue to address threats to the Nation's 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.

Computing Workforce
CISE will continue CISE Pathways to Revitalized Undergraduate Computing Education (CPATH), an education and workforce activity that envisions a U.S. workforce with the computing competencies and skills necessary to insure the Nation's health, security and prosperity in the 21st century. This workforce includes a cadre of computing professionals prepared to contribute to sustained U.S. leadership in computing in a wide range of application domains and career fields, and a broader professional workforce with knowledge and understanding of critical computing concepts, methodologies and techniques. CISE will also continue its emphasis on Broadening Participation in Computing (BPC), which aims to significantly increase the number of U.S. citizens and permanent residents receiving post secondary degrees in the computing disciplines.

Changes from FY 2007

Core Research and Education: +$21.00

Disciplinary and interdisciplinary research in the CNS core will increase by $21.0 million. This additional support will be allocated to research priorities such as those described above and will help improve the funding rate in CNS.

Computing Research Resources +$8.00

An additional $10.0 million will support pre-construction planning activities for the Global Environment for Networking Innovations (GENI), including support for the GENI Project Office. As the GENI effort ramps up, other research resources efforts will be scaled back by $2.0 million in the short term to accommodate additional funding for GENI.

INFORMATION AND INTELLIGENT SYSTEMS $154,630,000

The FY 2008 Budget Request for the Division of Information and Intelligent Systems (IIS) is $154.63 million, an increase of $35.33 million, or 29.6 percent, over the FY 2007 Request of $119.30 million.

Information and Intelligent Systems Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Information and Intelligent Systems	**$103.78**	**$119.30**	**$154.63**	**$35.33**	**29.6%**
Major Component:					
Research & Education Grants	103.78	119.30	154.63	35.33	29.6%

About IIS:

The Division of Information and Intelligent Systems 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 focused on human-centered computing, information integration and informatics, and robust intelligence. IIS activities also focus on the integration of research and education to prepare future generations of computer science and engineering professionals.

In general, 56 percent of the IIS portfolio is available for new research grants. The remaining 44 percent is used primarily to fund continuing grants made in previous years.

IIS Priorities for FY 2008

The FY 2008 Request is focused on new and emerging research areas related to Cyber-enabled Discovery and Innovation; on a new internationally focused program that will contribute to the development of a competitive, globally aware workforce; and on strengthening existing programs of research in information and intelligent systems.

Cyber-enabled Discovery and Innovation

In support of the American Competitiveness Initiative, IIS plans a significant effort in Cyber-enabled Discovery and Innovation. CDI is based on distinct, but related, conceptual areas that are ripe for advancement and application: knowledge extraction, complex interactions, computational experimentation and virtual environments. These areas comprise computational discovery. The conceptual area of virtual environments will receive the most focus from IIS. Virtual environments are rapidly developing throughout science and engineering (and the rest of the world) as important mechanisms to enhance discovery, learning, and innovation. CDI research in this area will develop new techniques for building and utilizing virtual environments, explore their properties in prototype form, and experiment with them as deployed across a range of scientific and engineering fields, both in discovery and educational settings.

International Activities
Through a new internationally focused program funded at $10.0 million, CISE will contribute to the development of a competitive, *globally aware* workforce. This program will foster international relationships and cooperative research and education activities that support CISE's mission and maximize the strategic value of its investments.

Integrative Intelligence
Since the earliest pursuits of artificial intelligence scientists have strived for progress by focusing on individual cognitive tasks, such as language, learning, and vision. Many decades of work have seen advances in these individual areas and the development of core methods that span these areas. In FY 2008, IIS will target the development of transformative projects that tackle the challenges of creating comprehensively intelligent systems that master and integrate multiple cognitive tasks.

Next Generation Networked Information
Computer networks are the backbone on which our information-laden society rests. The new visions for reliable and secure distributed computer networks targeted by CISE's investments in Global Environment for Networking Innovations (GENI) must be developed in lockstep with new visions for the future-generation information systems that will live on them. In FY 2008 IIS will support research on next-generation networked information systems, tackling such questions as: What will information systems look like when they reside in new generations of networks with nodes of greatly heterogeneous capability, mobility, and use? How can information be provided not only based on content but also context? What metaphors and models make it possible to provide coherence to the diverse ways users might access information in future networking environments? How can vastly heterogeneous, distributed, and uncoordinated sources of networked information be integrated and made comprehensible and useful for the unforeseen and diverse tasks to which it is relevant?

Creative Computer Science and Information Technology
Information technology is playing an increasing role in enhancing the capability of human creative thinking, problem solving, and innovation. In FY 2008, IIS will support research that capitalizes on the synergies between creativity and information technology, science, engineering, and design research. Anticipated research outcomes include new models of creative cognitive and computational processes, new approaches to education for students that encourage creativity and innovation, new modes of research that include creative professionals, and new tools to support human creativity, both individually and in collaboration.

Changes from FY 2007
The FY 2008 Request for IIS includes an increase of $35.33 million that will be directed toward the following areas:

Core Research and Education: +$25.33
Disciplinary and interdisciplinary research in the IIS core will increase by $25.33 million. This additional support will be allocated to research priorities as described above and will help improve the funding rate in IIS.

Computing Workforce: +$10.00
CISE addresses ACI education objectives through a new internationally focused program supporting International activities.

INFORMATION TECHNOLOGY RESEARCH **$78,240,000**

The FY 2008 Budget Request for the Information Technology Research (ITR) Subactivity is $78.24 million, a decrease of $43.35 million, or 35.7 percent, below the FY 2007 Request of $121.59 million.

Information Technology Research Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Information Technology Research	**$146.20**	**$121.59**	**$78.24**	**-$43.35**	**-35.7%**
Major Component:					
Research & Education Grants	146.20	121.59	78.24	-43.35	-35.7%

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 general, 71 percent of the ITR portfolio is available to make new research awards in computing fundamentals. The remaining 29 percent is used primarily to fund continuing grants made in previous years.

ITR Priorities for FY 2008

Funds redirected from the ITR Subactivity will be used to target IT priorities in the core CISE subactivities of CCF, CNS, and IIS. Remaining funds will target prominent CISE-wide IT research and education priorities as described below.

Discovery Research for Innovation

At a level of $50.0 million, CISE will support new research in computing fundamentals and research supporting larger-scale, experimental projects that promise IT systems that are more reliable and robust, have better and more predictable performance, provide useful new services, and exploit the potential of emerging technologies. Funded projects will permit full development and exploration of fundamental new concepts and ideas in the computing domain, and will promise significant contributions to the American Competitiveness Initiative.

Changes from FY 2007:

In FY 2008, CISE will redirect $43.35 million from the broad category of IT Research to IT priorities in the core CISE subactivities of CCF, CNS, and IIS.

ENGINEERING $683,300,000

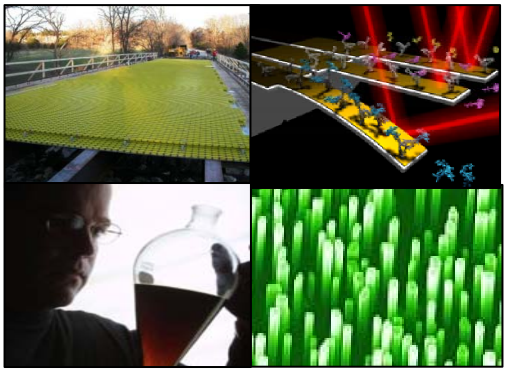
The FY 2008 Budget Request for the Directorate for Engineering (ENG) is $683.30 million, an increase of $54.75 million, or 8.7 percent, over the FY 2007 Request of $628.55 million.

Engineering Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Chemical, Bioengineering, Environmental and Transport Systems (CBET)	$125.09	$124.44	$144.97	$20.53	16.5%
Civil, Mechanical and Manufacturing Innovation (CMMI)	148.82	152.16	174.08	21.92	14.4%
Electrical, Communications and Cyber Systems (ECCS)	77.91	80.90	93.96	13.06	16.1%
Industrial Innovation and Partnerships (IIP)	109.65	120.08	128.39	8.31	6.9%
SBIR/STTR	*99.07*	*108.88*	*116.41*	*7.53*	*6.9%*
Engineering Education and Centers (EEC)	123.99	125.97	116.90	-9.07	-7.2%
Emerging Frontiers in Research and Innovation (EFRI)	-	25.00	25.00	-	-
Total, ENG	$585.46	$628.55	$683.30	$54.75	8.7%

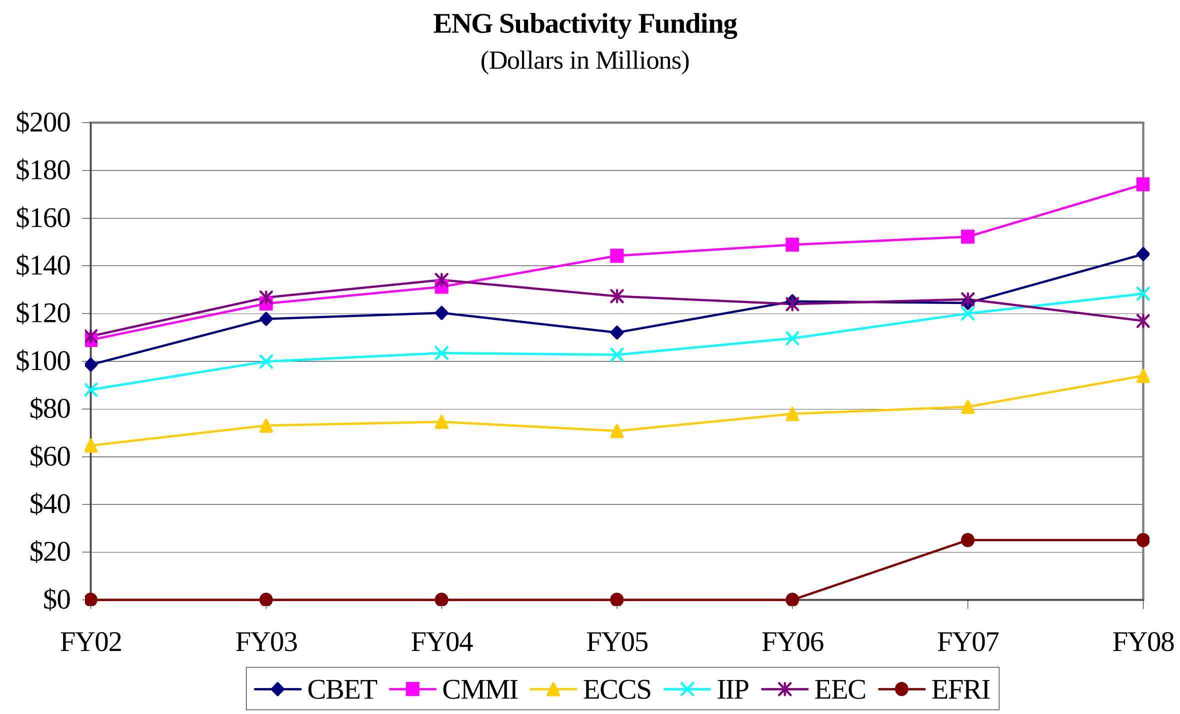
Engineering research and education are the cornerstones of innovation. They provide the tools necessary to secure our continued economic growth, energy independence, and national security, while helping our Nation achieve the broad goals and objectives outlined in the President's American Competitiveness Initiative.

Through its investments in cutting-edge and transformative research, the Directorate for Engineering is a vital link in this process – enabling engineers to design the innovative systems that have the potential to improve our standard of living, environmental stewardship, and industrial productivity.



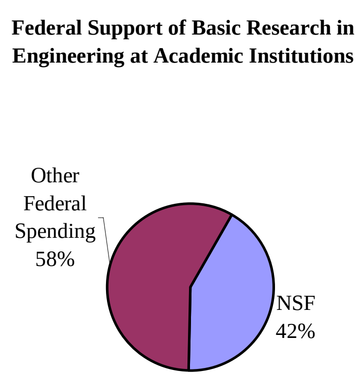
Engineering spans the frontiers – from designer materials and nanotechnology to alternative energy and understanding complex engineered and natural systems.

Engineering brings together imagination and ingenuity to create the fundamental knowledge and resources necessary to rise above today's pressing demands as well as strategically align our resources to address tomorrow's 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 homes and communities from natural disasters, making meaningful strides toward alternative energy sources, and educating a future workforce that leads the world in innovation, are just some of the areas where engineers are working toward solutions.



RELEVANCE

The Engineering Directorate is the single largest source of federal funding for university-based, fundamental engineering research – providing 42 percent of the total federal support in this area.



These investments in research and education have continually borne fruit, as evidenced by our Nation's perennial global leadership in innovation. ENG-supported research runs the gamut of high-impact, emerging technologies, such as hybrid communications systems, complex engineered systems, metabolic and cellular engineering, manufacturing frontiers, computer hardware, cyberinfrastructure, and nanotechnology.

Specific ENG research themes for FY 2008 and their relevance to the American Competitiveness Initiative (ACI) include:

- *Complex Engineered and Natural Systems* addresses unifying principles that enable modeling, prediction, and control of emergent behavior in complex systems ranging from critical infrastructure to the intersection of the life sciences and bioengineering. Whether exploring the neural processes that give rise to human intelligence, predicting global weather patterns, designing aircraft, or planning for catastrophic scenarios for our nation's infrastructure – an enabling body of knowledge on complex systems is essential. This research also directly relates to a number of specific ACI research goals, including: materials for improving structural performances during natural disasters; overcoming barriers to quantum information processing; and world-leading automation and control technologies.

- *Energy and the Environment* will drive frontier research to find the essential breakthroughs necessary for radical improvements in the cost, sustainability, and security of our nation's energy system. ENG currently is engaged in research on energy and the energy supply chain. These areas include biofuels, hydrogen production, solar cells, energy scavenging, and fuel cells. Several programs address environmental issues, power distribution, carbon sequestration, and process and system design for energy conversion. This research is closely tied with the ACI goals of: use of hydrogen and solar energy through basic research in materials; and research critical to nanotechnology, biotechnology, alternative energy, and the hydrogen economy through essential infrastructure.

- *Innovation* is a principal objective of engineering research and pervasive in ENG investments. ENG – through its investments in discovery and innovation – continues to create the knowledge base and the intellectual capital essential for technological innovation. ENG is uniquely able to integrate research, education, and innovation through three existing programs: Grant Opportunities for Academic Liaison with Industry (GOALI), Industry/University Cooperative Research Centers (I/UCRC), and Partnerships for Innovation (PFI).

- *Manufacturing Frontiers* focuses on research that catalyzes multiscale manufacturing, from fundamental metrology through atomic-scale control of raw materials. ENG's investments in manufacturing will help to create quality-engineered nanomaterials in quantities sufficient to meet future needs; perfect manipulation and manufacturing on the atomic and molecular scale; enable the design and assembly of predictable integrated systems; and facilitate the transfer of nanoscience discoveries in the laboratory to practical industrial applications. This area also directly impacts the ACI research goals of: world-class capabilities in nanofabrication and nanomanufacturing; improved sensor and detection capabilities resulting in world-leading automation and control technologies; and manufacturing innovations for more efficient production practices.

- *Nanotechnology* supports the ACI goals of: world-class capabilities in nanofabrication and nanomanufacturing; research critical to nanotechnology through essential infrastructure; and is applicable to most of the other ACI, Administration, and NSF research goals. ENG leads the nation in fundamental nanoscale science and engineering research. This leadership is both in NSF's launching and subsequent support of the interagency National Nanotechnology Initiative (NNI), and through its own investments in nanoscale research. The long-term objectives of this broad initiative focus on building a foundation of fundamental research to understand nanoscale concepts, and applying novel principles to the most promising opportunities in measuring and manipulating matter on the nanoscale.

The national engineering community helps guide the research process through ongoing interactions, including conferences and workshops, and most significantly through the Engineering Advisory Committee, which provides near- and long-term recommendations to help ENG advance the frontiers of discovery, enable technological innovation, and transform education to serve the current and future demands of society.

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

FY 2007 Request, ENG….…………………………………………………………………....$628.55

Chemical, Bioengineering, Environmental and Transport Systems +$20.53

The Division will increase support in key applications of the physical sciences, such as catalysis, chemical process design, environmental engineering, advanced materials, fuel cells, fluid flow, combustion, heat transfer, and particulate processes. These investments contribute to advances that are important for energy, the environment, transportation, information technologies, health-related products, and other areas to sustain and enhance US competitiveness and impact our daily lives.

Current high-emphasis applications of the life sciences include post-genomic engineering, tissue engineering, biophotonics, nano-biosystems, and biotechnology. Increased support will lead to improved biosensors, biomaterials, controlled drug release, bioimaging, medical devices and instrumentation, artificial organs, therapeutic agent bioprocessing, bioremediation, water and waste treatment, and food engineering.

Civil, Mechanical and Manufacturing Innovation +$21.92

Increased support in the areas related to analyzing, modeling, designing, building, and securing the nation's critical infrastructure, and manufacturing and service enterprise. CMMI will continue to increase investments in engineering education to foster a world-class engineering workforce. Support will also be increased for projects utilizing the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) and for hazard-related research.

Electrical, Communications and Cyber Systems +$13.06

Increased support for innovative research in nano and micro systems, communication systems and cyber systems that integrate physical devices and components with computational intelligence and networks. This will aid in the design, development, and implementation of new complex and hybrid systems with engineering solutions for a variety of domain-specific applications for the benefit of society. Additional funds will also support unsolicited proposals in the emerging areas of diagnostic and implantable devices; flexible electronics; neuromorphic engineering; quantum electronics; energy scavenging and alternative energy technologies, and interdependencies of critical infrastructure in power and communications.

Industrial Innovation and Partnerships +$8.31

IIP is home for the two congressionally mandated small business research programs, the Small Business Innovation Research (SBIR) program (+$6.73 million) and the Small Business Technology Transfer (STTR) program (+$800,000). In addition, IIP leverages industrial support through two research programs, the Industry/University Cooperative Research Centers (I/UCRC) program (+$480,000) and the Grants Opportunities for Academic Liaison with Industry (GOALI) program (+$300,000).

Engineering Education and Centers -$9.07

Support for Engineering Education and Nanoscale Science & Engineering Centers increases while support for the Engineering Research Centers (ERC) program decreases. The total number of ERCs will be reduced from 19 to the historical level of 15 as ENG moves into the next generation of ERCs.

Emerging Frontiers in Research and Innovation **+**$0.00

EFRI support remains level at $25.0 million and will foster 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. EFRI was established in FY 2007 as part of the Engineering Directorate reorganization.

Subtotal, Changes +$54.75

FY 2008 Request, ENG……………………………………………………………...…….$683.30

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

FY 2007 Request, ENG….…………………………………………………………………....$628.55

<u>Discovery Research for Innovation</u> +$51.85

Disciplinary and Interdisciplinary Research ($50.77 million).

The ENG research areas seamlessly interlace with the key areas outlined in the FY 2008 Administration Research and Development Budget Priorities; they align with the NSF Strategic Plan; and directly address the goals and programs contained in the American Competitiveness Initiative (ACI).

Support for core ENG research disciplines will be increased by $40.77 million. With these additional resources, ENG estimates a 3 percent increase in the research grant funding rate in FY 2008. ENG will continue to build on its strong system of merit review and investigator-initiated proposals, which advance the frontiers of knowledge and innovation by working across traditional boundaries and encouraging multidisciplinary, cutting-edge, and high-impact research. ENG's core represents a broad and synergistic convergence of fields, disciplines, and frontier opportunities and may be either newly emerging fields or long-standing challenges that are poised for major advancement. The Office of Emerging Frontiers in Research and Innovation (EFRI) will continue to identify, prioritize, and fund emerging frontier areas in engineering research, innovation, and education.

ENG also has a vital role to play in advancing a new NSF-wide investment area for FY 2008, Cyber-enabled Discovery and Innovation ($10.0 million). ENG broadly supports research in advanced cyber-enabled engineering to broaden the Nation's capability for innovation. This research focuses on a new generation of computationally based discovery concepts and tools to deal with complex, data-rich, and interacting systems. Investment in this area will enable new avenues of support in emerging areas such as modeling of the electric power grid, computational fluid dynamics, and research to create virtual environments for innovation. It also will expand education and research capabilities through supplements to graduate students in supercomputer and petascale computer centers, and through ENG's participation in the Network for Computational Nanotechnology (NCN), making available research and educational software for nanotechnology.

Engineering Research Centers (ERCs) and Other Centers (-$7.45 million).
Funding decreases by $9.93 million, to a total of $52.86 million. The total number of ERCs will be reduced from 19 to the historical level of 15 as ENG moves into the next generation of ERCs. The goal of Generation Three ERCs (Gen-3) is to create a culture of innovation in engineering research and education that links scientific discovery to technological innovation through transformational engineered systems research in order to advance technology and produce engineering graduates who will be creative innovators in a global economy. New features of Gen-3 include a translational small business component and the requirement that each center have an international partner. Nanoscale Science and Engineering Centers funding increases by $2.0 million, to a total of $23.79 million, and Industry/University Cooperative Research Centers (I/UCRC) increases by $480,000 to a total of $7.28 million

Small Business Innovation Research/Small Business Technology Transfer (+$7.53 million).
Funding increases by $7.53 million, to a total of $116.41 million to meet the mandated agency spending target of 2.80 percent of the agency's extramural research budget.

Faculty Early Career Development Program (CAREER) (+$1.0 million).
Funding increases for the CAREER program by $1.0 million, to a total for $38.40 million, for two additional awards.

<u>Preparing the Workforce of the 21st Century</u> +$1.50

Research Experience for Undergraduates (REU)
Support for the REU Supplements increases by $1.0 million, to a total of $5.30 million, providing support to approximately 65 additional students.

Research Experiences for Teachers (RET)
Support for the RET Supplements increases by $500,000, to a total of $4.60 million.

<u>Transformational Facilities and Infrastructure</u> +$0.90

Network for Earthquake Engineering Simulation (NEES)
Funding for operations and maintenance costs increase $900,000, to a total of $22.17 million.

<u>Stewardship</u> +$0.50

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 program support functions.

Subtotal, Changes +$54.75

FY 2008 Request, ENG…………….……………………………………………………...…….$683.30

NSF-WIDE INVESTMENTS

In FY 2008, the Directorate for ENG 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 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Biocomplexity in the Environment	$6.00	$4.00	-	-$4.00	-100.0%
Climate Change Science Program	1.00	1.00	1.00	-	-
Cyber-enabled Discovery and Innovation	-	-	10.00	10.00	N/A
Cyberinfrastructure	52.00	54.00	58.00	4.00	7.4%
Human and Social Dynamics	2.00	2.00	1.50	-0.50	-25.0%
Mathematical Sciences	2.88	1.46	-	-1.46	-100.0%
National Nanotechnology Initiative	127.77	137.02	139.02	2.00	1.5%
Networking and Information Technology R&D	11.20	11.20	21.20	10.00	89.3%

Biocomplexity in the Environment: With the conclusion of this priority area in FY 2007, funds will return to core programs for continued support.

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.

Cyber-enabled Discovery and Innovation: ENG's investment of $10.0 million in CDI will enable new avenues of support in emerging areas such as modeling of the electric power grid, computational fluid dynamics, and research to create virtual environments for innovation.

Cyberinfrastructure: ENG currently funds the operation and research program of NEES – the George E. Brown Jr. Network for Earthquake Engineering Simulation – NSF's first distributed-network cyberinfrastructure research facility. ENG also supports the National Nanotechnology Infrastructure Network (NNIN) and the Network for Computational Nanotechnology (NCN). In FY 2008, support increases by $4.0 million to a total of $58.0 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 cyberinfrastructure to enable frontier research in ENG domain areas.

Human and Social Dynamics: A total of $1.50 million will be invested in Decision Making and Risk and Dynamics of Human Behavior components of this priority area.

Mathematical Sciences: With the conclusion of this priority area in FY 2007, funds will return to core programs for continued support.

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. FY 2008 ENG support for NNI increases by $2.0 million, to a total of $139.02 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.

QUALITY

ENG maximizes the quality of the R&D it supports through the use of a competitive, merit-based review process. In FY 2006, the last year for which complete data exist, 95 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

The FY 2008 Budget Request is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals stated in the FY 2006-2011 Strategic Plan. These goals provide an overarching framework for progress in fundamental research and education and facilitate budget and performance integration.

Engineering by Strategic Outcome Goal

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Discovery	$494.28	$538.03	$589.88	$51.85	9.6%
Learning	52.14	51.85	53.35	1.50	2.9%
Research Infrastructure	30.12	30.67	31.57	0.90	2.9%
Stewardship	8.92	8.00	8.50	0.50	6.3%
Total, ENG	$585.46	$628.55	$683.30	$54.75	8.7%

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 2008 budget will 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

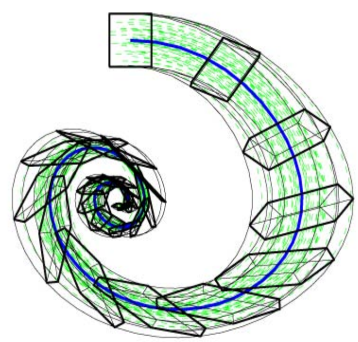
NEES investigators at UCSD's Seven Story Test Model. *Credit: Prof. Jose Restrepo, Dept. of Structural Engineering, UCSD.*

► **Cost Effective and Earthquake Resistant:** By applying innovative, intelligent design strategies, structural engineers at the University of California, San Diego, have successfully shown that new light-weight construction techniques are as earthquake-resistant as bulkier, more expensive methods.

By erecting a seven-story test building on a giant outdoor shake table – which is part of the NSF-supported Network for Earthquake Engineering Simulation (NEES) – the engineers duplicated the force of California's devastating 1994 Northridge Earthquake. Data from this test confirmed that novel designs and carefully placed reinforcements are just as effective at withstanding earthquake damage as the heavily reinforced, "hardened" buildings required by California building codes.

Full-scale tests of such large buildings have previously not been possible because of weight, space, and technical limitations of smaller indoor shake tables. The NEES shake table at UCSD can actually support a building roughly 10 times heavier than the one tested in this study. (CMMI)

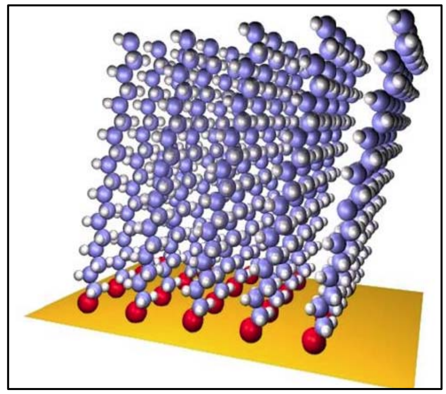
► **Modeling Uncertainty in Power Systems:** U.S. power systems are vulnerable to disruption from a variety of sources—natural events, terrorism, surges in power demand and supply, an aging power grid, and inadequate communications systems. When power systems fail, we lose electricity to operate our homes, businesses, factories, and computer networks. Realistic models of how power systems respond to disruptions are critical in protecting the nation's security and prosperity.



A diagram of the worst-case range of responses to a power system disturbance. *Credit: I. Hiskens, University of Wisconsin, Madison.*

Models must incorporate uncertainty about power systems operations and how they respond to different disturbances. Using worst-case analysis and a probabilistic approach, a researcher at the University of Wisconsin has developed an efficient and accurate approach. He quantifies uncertainties and portrays them visually, providing a clearer view of how power systems are likely to respond to different risks. This method is particularly effective in analyzing the potential for cascading failures—such as occurred in the Northeast in 2003. This allows power system managers to anticipate potentially devastating situations and develop appropriate operations strategies. (ECCS)

► **Hydrogen Storage Pulls Itself Together:** For hydrogen to become an economical and practical fuel alternative, engineers will need to solve a number of technological hurdles, including finding a safe and effective means of hydrogen storage and transportation. Researchers at the University of Washington's Engineered Biomaterials Engineering Research Center (UWEB) – through Asemblon Inc., a spin-off company – have created a new material that can store and release hydrogen on demand. What gives this material its unique properties is the fact that its molecules self-assemble into sheets called mono-layers, which align, row upon row. This structure allows hydrogen to be chemically stored and released as needed, which is vital for energy applications. Another important quality of the material is that it can be regenerated to a hydrogen-rich form that is suitable for re-use in hydrogen production. By making hydrogen storage and transportation more practical, this innovation may play an important role in our nation's future hydrogen economy. (EEC)



Graphic demonstrating how self-assembling materials align to enable hydrogen storage. *Credit: Dan Graham, Assemblon, Inc.*

Genosensor used to detect pathogens in ocean and coastal waters. *Credit: Image Courtesy of John Paul, USF.*

► **New Sensor Detects Pathogens in Coastal Waters:** Researchers at the University of South Florida have demonstrated a rapid, highly accurate genetics-based sensor for detecting pathogens in coastal or ocean water. The system – called a genosensor – samples seawater and partially purifies the RNA found in it to assess the presence of viruses or microbes. To ensure accuracy, the system checks the genosensor results with a molecular beam probe (a secondary sensor), which causes the sample to light up if pathogens are present. The researchers are working to develop a sensor-based platform to automatically monitor ocean and coastal waters, sending information in real-time to shore-based monitoring stations.

Initial sensor research has focused on detecting *Karenia brevis*, the microbe that causes "red tides," which devastates fish and marine mammals, and also causes respiratory problems for people and animals. The researchers developed an extremely sensitive sensor that detects *K. brevis*, even if just one cell is present in the seawater sample. The probe verifies results and provides minute-by-minute readings for ongoing measurements. (CBET)

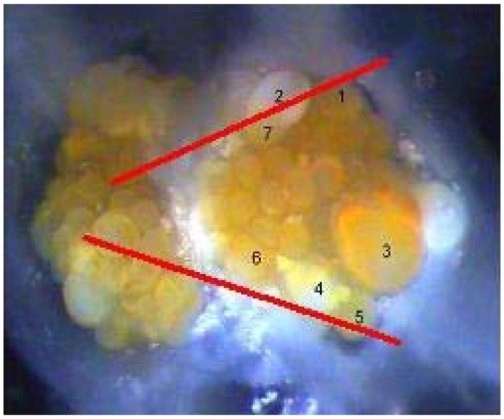
► **Partnering to Solve Real Problems:** Founders of the Learning Factory – a program that matches student teams with industrial problems – received the National Academy of Engineering's highest prize for educational innovation. "The Learning Factory is an internationally recognized leader in interdisciplinary industry-partnered, active learning." The program has been integrated into the curricula at Penn State, the University of Puerto Rico-Mayaguez, and the University of Washington. The program was designed to give students a unique experience and to attract underrepresented minorities to manufacturing engineering.

Mechanical engineering student creating a product prototype on a rapid prototyping machine in the Learning Factory. *Credit: John Lamancusa, Penn State University.*

More than 10,000 students have developed designs addressing the needs of more than 200 industrial partners through the Learning Factory.

Student teams define and characterize the problem, develop prototypes, write a business proposal to address the problem, and prepare a final report. Students face real-world pressures to develop quality products "on time" and "under budget" – critical skills in today's globally competitive world. (CMMI)

► **New Approaches to Neural Imaging:** Functional optical coherence tomography (FOCT) has the potential to be a versatile diagnostic tool – similar to ultrasound – with greater speed, flexibility, and precision. FOCT splits a light beam in two. It scans one beam across a tissue to produce a cross sectional image. It scans the other beam across a known material. The two signals are compared for differences in the intensity of the light that is scattered or reflected back. These differences provide information about tissue structure and function.



Cross sectional image of nerve fibers, abdominal ganglion, and single neurons in Aplysia californica (sea slug). *Credit: Stephen Boppart Nanoelectronics and Biophotonics Group, Beckman Institute, University of Illinois.*

To be effective, FOCT requires fast and stable optical scans. A CAREER awardee at the University of Illinois has successfully used FOCT to investigate neural activity and communication patterns at the cellular and molecular level. Using special imaging techniques and tools that he developed for rapidly processing images, the researcher captured optical changes in neural fibers of the sea slug (Aplysia californica) on a microsecond time scale with the precision of a few microns. This is an important step in developing FOCT as an effective tool for non-invasively characterizing physiological changes in single neurons, nerve fibers, and brain tissue. (CBET)

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 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Senior Researchers	5,648	5,930	6,226
Other Professionals	1,278	1,344	1,475
Postdoctorates	396	426	470
Graduate Students	5,025	5,276	5,540
Undergraduate Students	2,186	2,427	2,650
Total Number of People	14,533	15,403	16,361

ENG Funding Profile

	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Statistics for Competitive Awards:			
Number	1,737	1,750	1,855
Funding Rate	18%	20%	24%
Statistics for Research Grants:			
Number of Research Grants	956	1,050	1,265
Funding Rate	14%	15%	18%
Median Annualized Award Size	$90,000	$93,000	$93,500
Average Annualized Award Size	$110,032	$115,000	$118,000
Average Award Duration, in years	3.0	3.0	3.0

CHEMICAL, BIOENGINEERING, ENVIRONMENTAL AND TRANSPORT SYSTEMS $144,970,000

The FY 2008 Budget Request for the Chemical, Bioengineering, Environmental and Transport Systems Division (CBET) is $144.97 million, an increase of $20.53 million, or 16.5 percent, above the FY 2007 Request of $124.44 million.

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

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Chemical, Bioengineering, Environmental, and Transport Systems	**$125.09**	**$124.44**	**$144.97**	**20.53**	**16.5%**
Major Components:					
Research and Education Grants	113.83	111.95	131.86	19.91	17.8%
Science and Technology Center (STC)	4.08	4.00	4.00	-	-
National Nanoscale Infrastructure Network (NNIN)	3.17	3.20	3.20	-	-
Nanoscale Science and Engineering Centers (NSEC)	4.01	5.29	5.91	0.62	11.7%

About CBET:

The Chemical, Bioengineering, Environmental and Transport (CBET) Division supports research to enhance and protect US national health, energy, environment, security, and wealth. Through CBET, the physical, life and social sciences are merged in engineering research and education, resulting in advances in the rapidly evolving fields of bioengineering and environmental engineering, and in areas that involve the transformation and/or transport of matter and energy by chemical, thermal, or mechanical means. CBET investments contribute significantly to the knowledge base and to the development of the workforce for major components of the U.S. economy, including chemicals, pharmaceuticals, medical devices, forest products, metals, petroleum, food, textiles, utilities, and microelectronics. CBET supports research in biotechnology and the chemical, environmental, biomedical, mechanical, civil, and aerospace engineering disciplines.

To achieve synergy across disciplinary boundaries, CBET is organized in four program clusters: Chemical, Biochemical, and Biotechnology Systems; Transport and Thermal Fluids Phenomena; Biomedical Engineering and Engineering Healthcare; and Environmental Engineering and Sustainability

In general, 61 percent of the CBET portfolio is available for new research grants. The remaining 39 percent funds continuing grants made in previous years.

CBET Priorities for FY 2008:

The Division will continue to support research in key applications of the physical sciences, such as catalysis, chemical process design, environmental engineering, advanced materials, fuel cells, fluid flow, combustion, heat transfer, and particulate processes. These investments contribute to advances that are important for energy, the environment, transportation, information technologies, health-related products, and other areas to sustain and enhance US competitiveness and impact our daily lives.

Current high-emphasis applications of the life sciences include post-genomic engineering, tissue engineering, biophotonics, nano-biosystems, and biotechnology. This research leads to improved biosensors, biomaterials, controlled drug release, bioimaging, medical devices and instrumentation, artificial organs, therapeutic agent bioprocessing, bioremediation, water and waste treatment, and food engineering.

While sustaining the vitality of these core research areas, CBET actively supports the following theme 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 Water and Environmental Research Systems (WATERS) Network project, which has, as its objective, the transformation of water resource engineering research at a national scale. Resilient, sustainable infrastructure is a new area of support for several programs within the division.

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.

Cyber-enabled Discovery and Innovation (CDI): CDI efforts are pervasive throughout CBET's programs. Projects involving CDI are funded throughout CBET, and draw increasingly on High Performance Computing (HPC) capabilities that will be enhanced by NSF-level CDI initiatives. Multi-scale modeling (MSM) is growing rapidly in the academic communities funded by CBET. CBET hosts the interagency solicitation on MSM in Biomedical, Biological, and Behavioral (BBB) systems. CBET is also part of an interagency working group on multi-scale chemical sciences and process informatics kinetics.

Complex Engineered and Natural Systems: CBET invests heavily in complex natural systems through the environmental programs, including the plan for the WATERS Network, and through projects awarded in the Biomedical Engineering and Engineering Healthcare cluster. Examples of these types of awards include the development of artificial retinal implants for sight restoration and neurotechnology-based computer interfaces to allow brain-injured people use of their limbs.

CBET continues to participate in major NSF wide initiatives and supports large scale facilities through Science and Technology Centers, Nanoscale Engineering Centers and the National Nanotechnology Infrastructure Network.

Changes from FY 2007:

- Support of $3.75 million for the new Cyber-enabled Discovery and Innovation (CDI) key investment area.
- Support for the National Nanotechnology Initiative (NNI) increases by $620,000 in core research areas and NSEC support to a total of $43.44 million.
- An increase of $16.16 million to support leading edge, frontier research in core programs and in support of the Engineering research themes.

CIVIL, MECHANICAL AND MANUFACTURING INNOVATION $174,080,000

The FY 2008 Budget Request for the Civil, Mechanical and Manufacturing Innovation Division (CMMI) is $174.08 million, an increase of $21.92 million, or 14.4 percent, above the FY 2007 Request of $152.16 million.

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

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Civil, Mechanical and Manufacturing Innovation	**$148.82**	**$152.16**	**$174.08**	**$21.92**	**14.4%**
Major Components:					
Research and Education Grants	121.76	124.31	144.81	20.50	16.5%
Network for Earthquake Enginnering and Simulation (NEES)	20.55	21.27	22.17	0.90	4.2%
National Nanoscale Infrastructure Network (NNIN)	1.63	1.65	1.65	-	-
Nanoscale Science and Engineering Centers (NSEC)	4.88	4.93	5.45	0.52	10.5%

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 analyzing, modeling, 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 areas: engineering infrastructure systems, innovation science and decision engineering, and materials transformation and mechanics. These areas will provide funds for the creation of necessary knowledge to design and secure the nation's infrastructure, and to grow our nation's wealth-producing enterprises.

A major portion of CMMI's portfolio supports the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) and hazard-related research. NEES is a system of 15 experimental facilities located at universities across the United States, which work together via cyberinfrastructure. This research facility addresses important challenges in earthquake and tsunami engineering research that previously could not be addressed, such as testing structures at near to full scale. Investments in fundamental earthquake engineering and other hazard-related research enables NSF's Engineering Directorate to quickly send research teams to gather ephemeral data immediately following natural as well as man-made disasters. The fundamental knowledge gained from these investments is being used to design predictive systems for the nation's infrastructure to mitigate damage, down time, and loss of life from a wide range of hazards.

CMMI's design, manufacture, and service portfolio is the largest of the federal agencies that support fundamental research and discovery that is driven by innovative research ideas from the community rather than narrowly defined specifications. 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, 63 percent of the CMMI portfolio is available for new research grants. The remaining 37 percent funds continuing projects made in previous years and operation of facilities and centers.

CMMI priorities for FY 2008:

CMMI's priorities for FY 2008 align with ENG's priorities in:

- *Manufacturing Frontiers* by supporting research in the enabling processes, systems and enterprises to advance nanomanufacturing and the technology for healthcare delivery.
- *Complex Engineered and Natural Systems* by supporting research that leads to fundamental knowledge of complex systems and their modeling and by supporting research that leads to technologies for the protection, maintenance, or modification of the nation's critical civil and cyber infrastructure.
- In addition, CMMI will collaborate in advancing ENG's theme areas of: *Innovation* and *Nanotechnology*.

A major priority for the CMMI division is support for NEES research, operations, and grand challenge research. To date, 33 research projects have now been funded to utilize the NEES facilities. Current grand challenge research projects address the seismic vulnerability of nonductile concrete buildings in urban areas and port structures. In FY 2008, research will continue to involve experimental and theoretical simulations as the NEES facilities as well as expand educational outreach.

CMMI is engaged with its research community to focus its investment priorities. This includes several workshops on fundamental research needs in the area of jointed structures, cosponsored with Department of Defense agencies, workshops for the Mechanical Engineering and Civil and Environmental Engineering communities for their future research directions.

CMMI supports nanoscale science and engineering, with programs in the Materials Transformation and Mechanics cluster, including Nanomanufacturing and Nano/Bio-Mechanics. These programs have a critical role in converting discoveries into innovations, and are a key component of the Directorate's *Nanotechnology* theme 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. CMMI's Summer Institute on Nano Mechanics and Materials continues to train 150 current and prospective faculty members per year in these areas.

Changes from FY 2007:

- Support of \$3.13 million for the new Cyber-enabled Discovery and Innovation investment area.
- Support for the National Nanotechnology Initiative (NNI) increases by \$520,000 in core research areas and NSEC support to a total of \$28.79 million.
- An increase of \$17.37 million to support leading edge, frontier research in core programs and in support of the Engineering research themes.
- An increase of \$900,000 to a total of \$22.17 million will continue to accommodate the operations phase for the Network for Earthquake Engineering Simulation.

ELECTRICAL, COMMUNICATIONS AND CYBER SYSTEMS $93,960,000

The FY 2008 Budget Request for the Electrical, Communications and Cyber Systems (ECCS) Division is $93.96 million, an increase of $13.06 million, or 16.1 percent, over the FY 2007 Request of $80.90 million.

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

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Electrical, Communications and Cyber Systems	**$77.91**	**$80.90**	**$93.96**	**$13.06**	**16.1%**
Major Components:					
Research and Education Grants	65.91	69.19	81.91	12.72	18.4%
Nanoscale Science and Engineering Centers (NSEC)	3.13	3.16	3.50	0.34	10.8%
National Nanoscale Infrastructure Network (NNIN)	4.77	4.55	4.55	-	-
Science and Technology Center (STC)	4.10	4.00	4.00	-	-

About ECCS:

ECCS will address fundamental research issues underlying device and component technologies, power, controls, computation, networking, communications and cyber technologies. ECCS will support the integration and networking of intelligent systems at the nano, micro and macro scales for a variety of application domains 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 to achieve the goals of the American Competitiveness Initiative. ECCS will integrate education into its research programs to ensure the preparation of a diverse workforce for the 21st century that can enable innovative advances in emerging technologies as drivers of the global economy.

ECCS is organized around three programs that will focus on research and educational issues of device and component technologies, network and computational technologies, and systems engineering: (1) Electronics, Photonics and Device Technologies (EPDT); (2) Power, Controls and Adaptive Networks (PCAN); and (3) Integrative, Hybrid and Complex Systems (IHCS).

In general, 69 percent of the ECCS portfolio is available for new research grants; the remaining 31 percent funds continuing grants made in prior years.

ECCS Priorities for FY 2008:

The Electronics, Photonics and Device Technologies (EPDT) program will seek to improve the fundamental understanding of devices and components based on the principles of electronics, photonics, magnetics, organics, electro-optics, electromechanics, and related physical phenomena. The program will enable discovery and innovation in advancing the frontiers of spin electronics, molecular electronics, bioelectronics, silicon nanoelectronics and beyond, nonsilicon electronics, flexible electronics, optoelectronics, microwave photonics, power electronics, and mixed signal devices. EPDT will further support related topics in quantum engineering, novel electromagnetic materials-based devices, radio frequency integrated circuits, and reconfigurable antenna for telecommunications, telemedicine and other wireless applications. EPDT will provide additional emphasis on emerging areas of diagnostic and implantable devices and will continue its support for manipulation and measurement with nanoscale precision through new approaches for tools.

The Power, Controls and Adaptive Networks (PCAN) 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, brain-like networked architectures performing real-time learning, neuromorphic engineering, telerobotics and systems theory. PCAN will place a strong emphasis on critical infrastructure aspects of electric power networks and grids, including generation and integration (InterGrid) of renewable, sustainable and distributed energy systems in large power networks, high power electronics, and understanding of associated regulatory and economic structures. PCAN will provide additional emphasis on emerging areas, such as quantum and molecular modeling and simulation of devices and systems, energy scavenging and alternative energy technologies, and interdependencies of critical infrastructure in power and communications.

The Integrative, Hybrid and Complex Systems (IHCS) program is intended to spur visionary systems-oriented activities in collaborative research and education environments for multidisciplinary integrative activities. The program will support innovative research in nano/microsystems, communication systems, and cyber systems that integrate physical devices and components with computational intelligence and networks. The goal is to design, develop, and implement, new nano/micro/macro complex and hybrid systems with engineering solutions for a variety of domain-specific applications. Some examples include: system-in-a-package; system-on-a-chip; wireless networks of handheld or wearable computing devices; integrated hybrid optical and electronic systems for high-speed computation and communications; distributed sensing and actuation in telemedicine; ambient intelligent systems for homes of the future; and self-organizing blackout-free electric power grid.

ECCS will continue to provide support for specialized resources and infrastructure that facilitate research and educational activities, including NNIN, STC, NSEC and NSEE, as well as crosscutting activities. 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 2007:

- Support of $3.12 million for the new NSF-wide Cyber-enabled Discovery and Innovation (CDI) investment area.
- Support for the National Nanotechnology Initiative (NNI) increases by $340,000 in core research areas and NSEC support to a total of $39.12 million.
- An increase of $9.60 million to support leading edge, frontier research in core programs and in support of the Engineering research themes.

INDUSTRIAL INNOVATION AND PARTNERSHIPS $128,390,000

The FY 2008 Budget Request for the Industrial Innovation and Partnerships (IIP) Division is $128.39 million, an increase of $8.31 million, or 6.9 percent, over the FY 2007 Request of $120.08 million.

Industrial Innovation and Partnerships Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Industrial Innovation and Partnerships	**$109.65**	**$120.08**	**$128.39**	**$8.31**	**6.9%**
Major Components:					
Small Business Innovation Research (SBIR)	88.57	97.47	104.20	6.73	6.9%
Small Business Technology Transfer (STTR)	10.50	11.41	12.21	0.80	7.0%
Grant Opportunities for Academic Liaison with Industry (GOALI)	4.00	4.40	4.70	0.30	6.8%
Industry/University Cooperative Research Centers (I/UCRC)	6.58	6.80	7.28	0.48	7.1%

About IIP:

The Division of Industrial Innovation and Partnerships serves the entire foundation by fostering partnerships aimed at advancing technological innovation. The division is organized to respond to the American Competitiveness Initiative by catalyzing the transformation of discovery into societal benefits through stimulating partnerships for innovators. IIP is home for the two congressionally mandated small business research programs, the Small Business Innovation Research program (SBIR) and the Small Business Technology Transfer program (STTR). In addition, IIP leverages industrial support through two research programs, the Industry/University Cooperative Research Centers (I/UCRCs) and the Grants Opportunities for Academic Liaison with Industry (GOALI) program.

Twice each year, SBIR and STTR release proposal solicitations containing topics targeted to the innovative small businesses in the United States. 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 Industry/University Cooperative Research Centers (I/UCRC) 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, guiding 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.

The Grant Opportunities for Academic Liaison with Industry (GOALI) 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.

IIP Priorities for FY 2008:

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, and a supplement to qualifying Phase I grantees, were launched in 2006. Starting in FY 2006, SBIR and STTR programs reversed the downward trend in funding rate from a low of 14 percent by controlling release of solicitation topics. With increased funding in 2008, the target is to achieve 20 percent funding rate.

The 47 I/UCRCs work 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 launched a supplemental research initiative to advance the underlying fundamental science and technology of the centers. Currently, the I/UCRC and SBIR/STTR programs are exploring synergistic academic-small business partnership opportunities as a model to accelerate the innovation process.

The strategic plan for the Directorate for Engineering calls for increasing partnerships between academic and industrial communities. GOALI is well positioned to directly impact this objective. GOALI leverages its budget with support from other academic research programs by a factor of four-to-one. In FY 2008, the GOALI program will seek opportunities to accelerate innovation, strengthening the discovery knowledge base for a quicker transformation of discovery to societal benefit.

Changes from FY 2007:

- Increase of $6.73 million, to a total of $104.20 million for the Small Business Innovation Research program.
- Increase of $800,000, to a total of $12.21 million for the Small Business Technology Transfer program.
- Funding increases $480,000, to a total of $7.28 million for the I/UCRC program.
- Increase of $300,000, to a total of $4.70 million for GOALI program.

ENGINEERING EDUCATION AND CENTERS $116,900,000

The FY 2008 Budget Request for the Engineering Education and Centers (EEC) Division is $116.90 million, a decrease of $9.07 million, or 7.2 percent, from the FY 2007 Request of $125.97 million.

Engineering Education and Centers Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Engineering Education and Centers	**$123.99**	**$125.97**	**$116.90**	**-9.07**	**-7.2%**
Major Components:					
Research and Education Grants	43.89	50.35	50.69	0.34	0.7%
Engineering Research Centers (ERC)	62.31	62.79	52.86	-9.93	-15.8%
Earthquake Engineering Research Centers (EERC)	6.00	-	-	-	N/A
Nanoscale Science and Engineering Centers (NSEC)	8.44	9.48	10.00	0.52	5.5%
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, 89 percent of the EEC portfolio is used to fund centers, graduate fellowships, and undergraduate programs. Approximately 9 percent of the EEC portfolio is available for new research grants.

EEC Priorities for FY 2008:

In FY 2008, EEC will provide support for Engineering Research Centers, Nanoscale Science and Engineering Centers, engineering education research, and engineering workforce development. Approximately 57 percent of the EEC budget supports center related activities, with the remaining 43 percent supporting engineering education and workforce development programs.

In FY 2007, fifteen Engineering Research Centers received funding. Examples of center research would include: research and development 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 were 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.

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 2008, research will be supported to improve the development, management, and productivity of quality engineering education at both the undergraduate and graduate level. 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 2008 at their current levels.

Changes from FY 2007:

- Support for the Research and Education Grants increases by $340,000 to a total of $50.69 million.
- Support for Nanoscale Science & Engineering Centers increases by $520,000, to a total of $10.0 million.
- Funding for ERCs decreases by $9.93 million, to a total of $52.86 million as the total number of centers is returned to the historical level of fifteen and funding of some previously available supplemental programs is reduced. Funds are being reallocated to the three primary ENG research divisions to help further buoy the very low ENG funding rate for research grants.

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

The FY 2008 Budget Request for the Office of Emerging Frontiers in Research and Innovation (EFRI) is $25.0 million, equal to the FY 2007 Request of $25.0 million.

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

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Emerging Frontiers in Research and Innovation	**-**	**$25.00**	**$25.00**	**-**	**-**

About EFRI:

The Office of Emerging Frontiers in Research and Innovation (EFRI) was established in FY 2007 as a result of strategic planning and reorganization of NSF Engineering Directorate (ENG). Motivated by the vision of ENG to be the global leader in advancing the frontiers of fundamental engineering research, EFRI serves a critical role in helping ENG focus on important emerging areas in a timely manner.

Each year EFRI recommends, prioritizes, and funds interdisciplinary initiatives at the emerging frontier of engineering research and education. These emerging frontiers research areas are frequently found in transformative 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 enables the Engineering Directorate to pursue these interdisciplinary areas by allowing the engineering community to come forward with new and 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.

EFRI investments represent transformative opportunities, potentially 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. 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. infrastructures and interests throughout the world. EFRI will have the necessary flexibility to target our long-term challenges, while retaining the ability and agility to adapt as new challenges demand.

In general, 100 percent of the EFRI portfolio is available for new research grants.

EFRI Priorities for FY 2007:

The role of the EFRI Office 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 input from a number of sources – the community, ENG leadership, advisory committees, workshops, professional societies, academies, proposals and awards, and NSF committees of visitors. Yet, in the case of directed specified topics, the ENG Program Directors will play the central role within NSF.

EFRI will operate by the following process:

- At the beginning of each Fiscal 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. ENG leadership will evaluate the recommendations and make the final EFRI allocation decisions on list of topics.
- Based on this list of topics, working groups will generate proposed announcements.
- These lists of topics will be presented to the ENG Advisory Committee at their spring meeting.
- 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 2008 will better enable the Engineering Directorate to meet its strategic goal of fostering frontier and transformative research. Topics for EFRI support will typically relate to the five key ENG Themes. These are: *Complex Engineered and Natural Systems*, which addresses unifying principles that enable modeling, prediction, and control of emergent behavior in complex systems, *Energy and the Environment*, which includes frontier research to improve the cost, sustainability, and security of our nation's energy system, *Innovation*, which enables national competitiveness and the ability to foster and catalyze innovation, and the research needed to move from fundamental knowledge to societal benefit, *Manufacturing Frontiers*, which includes research that catalyzes multiscale manufacturing, from fundamental metrology through atomic-scale control of raw materials, and *Nanotechnology*, which drives our nation's efforts to lead the world in fundamental nanotechnology research with topics that span both active and complex nanosystems that are critical for frontier technologies that harness the integration of biology, neurology, energy, and water resources.

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 resides within the Office of the Assistant Director for Engineering and considers areas of emerging frontiers of engineering research, innovation, and education. The EFRI Office identifies and prioritizes emerging frontier areas of research and education, and provides resources for pursing these priorities.

Changes from FY 2007: No change is requested over FY 2007.

GEOSCIENCES $792,000,000

The FY 2008 Budget Request for the Directorate for Geosciences (GEO) is $792.0 million, an increase of $47.15 million, or 6.3 percent, over the FY 2007 Request of $744.85 million.

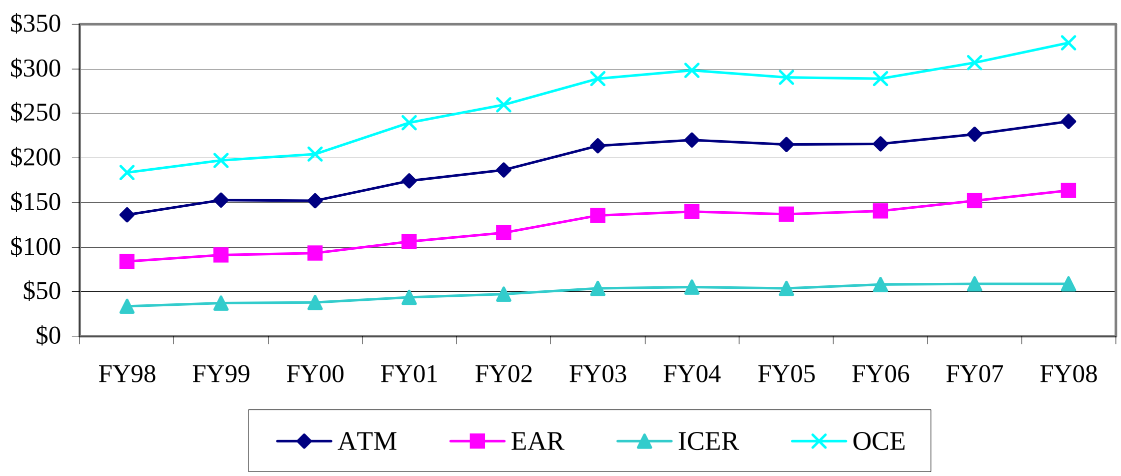
Geosciences Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Atmospheric Sciences (ATM)	$216.13	$226.85	$240.84	$13.99	6.2%
Earth Sciences (EAR)	140.35	152.30	163.30	11.00	7.2%
Innovative & Collaborative Education and Research (ICER)	58.37	58.57	58.57	-	-
Ocean Sciences (OCE)	289.09	307.13	329.29	22.16	7.2%
Total, GEO	$703.95	$744.85	$792.00	$47.15	6.3%

Totals may not add due to rounding.

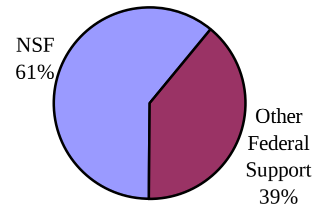
The Directorate for Geosciences (GEO) directly contributes to innovation and competitiveness through its broad portfolio of investments in fundamental research, facilities, and instrumentation that enable discovery, innovation, and integrated education and research activities that increase the effectiveness of the science and engineering workforce. As the principal source of federal funding for university-based fundamental research in the geosciences, GEO addresses the Nation's need to understand, predict, and respond to environmental events and changes. GEO-supported research also advances our ability to predict natural phenomena of economic and human significance, such as climate changes, weather, earthquakes, marine ecosystem change, and disruptive events in the solar-terrestrial environment.

GEO Subactivity Funding
(Dollars in Millions)



RELEVANCE

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 61 percent of the total federal support in these areas. In addition to playing a critical role in addressing the Nation's need to understand, predict, and respond to environmental events and changes, GEO 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. GEO investments include many environmental studies coordinated through the U.S. Climate Change Science Program. GEO supports many national and global observational facilities and other research infrastructure for land, ocean, and atmospheric processes.

GEO supports basic research that advances the frontiers of knowledge and drives technological innovation while improving our understanding of the many processes that affect the global environment. These processes include the role of the atmosphere and oceans in climate, the planetary water cycle, and the relative importance of natural variability and increased concentrations of greenhouse gases in the atmosphere as they relate to climate change. 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, tornados, hurricanes, tsunamis, and drought. Basic research supported by GEO 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.

Activities supported by GEO enable discovery, innovation, and integrated education and research. As such, many GEO programs support the American Competitiveness Initiative theme of fostering innovation. Activities supported by GEO are well-aligned with the Administration’s research and development priorities, including investments in high-end computing, improving our ability to understand and respond to global environmental issues, and to improve the quality of life. Finally, geoscience research directly contributes to improving our ability to live sustainably on Earth.

GEO is poised to foster advances in fundamental understanding of a variety of Earth system processes ranging from the interaction of the solar wind with Earth’s magnetosphere (space weather) to the structure and dynamics of the Earth’s deep interior and core. GEO is NSF’s lead partner in the U.S. Climate Change Science Program, and plays a critical role in advancing our understanding of the basic drivers of global environmental change and the Earth’s responses. A major thrust in FY 2008 is responding to the near-term priorities contained in the Ocean Research Priorities Plan. These near-term priorities are: Forecasting the Response of Coastal Ecosystems to Persistent Forcing and Extreme Events, Comparative Analysis of Marine Ecosystem Organization, Sensors for Marine Ecosystems, and Assessing Meridional Overturning Circulation Variability. A major theme in FY 2008 is supporting the infrastructure which has become essential to the successful conduct of modern geoscience research. Investment in the operation of the EarthScope facility and Ocean Drilling activities are both receiving significantly increased investment in FY 2008.

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

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

Atmospheric Sciences (ATM) +13.99

Increased support will augment research to understand and predict environmentally extreme events and to understand the effects of biogeochemical cycles. Increased support will also be provided for advanced cyberinfrastructure and numerical models; and to increase participation in key interagency and international programs such as the US Climate Change Science Program, the U.S. Weather Research program and the National Space Weather Program. Support for atmospheric observing facilities and the National Center for Atmospheric Research will increase to enable continued operation at FY 2007 levels.

Earth Sciences (EAR) +$11.00

Increased funding is focused on operational and scientific support of the EarthScope facility, which is being constructed through the MREFC account. Research support will increase slightly to enable maintenance of funding rates at FY 2007 levels.

Innovative & Collaborative Education and Research (ICER) +$0.00

In FY 2008, support for international collaborative activities and other cross-directorate programs will remain level, enabling continued international collaborations, maintenance of crosscutting diversity and education programs, and programs focused on integrated earth systems research.

Ocean Sciences (OCE) +$22.16

Areas receiving increased funding support include developmental activities related to the Ocean Observatories Initiative, operation of the Academic Research Fleet, and operational support for the Integrated Ocean Drilling Program, which utilizes the drillship currently undergoing a refit supported through the MREFC Account. Increased support will also target the near-term research priorities of the Ocean Research Priorities Plan.

Subtotal, Changes +$47.15

FY 2008 Request, GEO…………………………………………………………………...……..$792.00

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

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

<u>Discovery Research and Innovation</u> +$15.29

Disciplinary and Interdisciplinary Research (-$1.71 million)

Geoscience investments in fundamental research will continue to advance the frontiers of knowledge and discovery by working across traditional boundaries and encouraging multidisciplinary, cutting-edge, and high-impact research. Contributing to American technical innovation and scientific leadership, these investments directly support priorities associated with the American Competitiveness Initiative as well as the agency-wide research and development priorities, particularly those related to innovation, understanding global environmental issues, natural disasters, and improving the future quality of life. A small amount of support from existing programs is being redirected to emphasize activities that support other priority investments.

Ocean Research Priorities Plan (+$17.0 million)

GEO will support the near-term priorities presented in the Ocean Research Priorities Plan: Forecasting the Response of Coastal Ecosystems to Persistent Forcing and Extreme Events, Comparative Analysis of Marine Ecosystem Organization, Sensors for Marine Ecosystems, and Assessing Meridional Overturning Circulation Variability. Research activities across the geosciences will support greater understanding in these key areas.

Transformational Facilities and Infrastructure +$29.52

Academic Research Fleet (-$100,000)

GEO is the primary supporter of operations of the national Academic Research Fleet. Over the past five years, the cost of operational support has risen significantly, driven by many factors including increased costs for fuel, personnel, and new port security requirements. For example, in FY 2003, GEO's investment of $65.20 million in the Academic Research Fleet supported approximately 3,000 ship operating days. Although funding has increased since then, the number of ship operating days supported has fallen to 2,000 days at sea, far short of the expected demand of approximately 3,000 days. Despite an increase for ship operations of $3.10 million, to a total of $80.60 million, only 2,000 ship operating days can be supported.

In addition to capacity needs, the capability of the Academic Research Fleet is declining as many vessels approach the end of their safe operational lifetimes and their instrumentation becomes outdated. Two acquisitions are underway to respond to the most pressing needs. One is the first in a planned series of Regional-class Research Vessels ($14.0 million, a reduction of -$1.10 million from FY 2007) to replace aging and less capable ships. The second acquisition is the development and construction of a next-generation, human-occupied research submersible to replace the aging ALVIN ($3.0 million, a reduction of $2.10 million from FY 2007). This reduced level was planned as construction shifts into the less costly aspects of outfitting.

EarthScope (+$10.0 million)

Operational support of the EarthScope facility being constructed through the MREFC account will increase by $10.0 million to a total of $21.61 million. This level of operational support will enable operation of the facility as additional elements become operational during FY 2008.

Incorporated Research Institutions for Seismology (IRIS) (-$1.50 million)

Operational support of the IRIS facility will total $11.40 million, less than the FY 2007 Request but level with the FY 2006 operating budget. This reduction will result in a slowing of the rate of repair, replacement, and upgrade of seismic stations.

Digital Libraries (-$1.60 million)

In FY 2008, support for GEO's digital library program will end. This program proved the value of online, digital learning resources related to the geosciences, but due to the growth of the internet and greatly increased usability through commercial search capabilities, support of this activity is no longer needed.

Ocean Drilling Activities (+$12.20 million)

The Integrated Ocean Drilling Program, including operation of a new Scientific Ocean Drilling Vessel acquired and outfitted with support from the MREFC account, will increase by $12.20 million to a total of $38.0 million. This increase reflects the start of full program operations.

Ocean Drilling Program (-$2.0 million)

The Ocean Drilling Program officially ended in FY 2003. FY 2007 was the final year of support for ramp-down activities associated with this successful program.

Ocean Observatories (+$6.80 million)

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 $6.80 million to a total of $15.10 million. This increase will support operation of initial elements of the observatory as they are installed.

Research Resources (+$1.70 million)

Support for smaller infrastructure investments and community research resources will increase by $1.70 million. Primarily in the observation-intensive atmospheric sciences, these additional investments will enable infrastructure services to be maintained at FY 2007 levels.

National Center for Atmospheric Research (NCAR) (+$4.02 million)

NCAR is a Federally Funded Research and Development Center (FFRDC) supported by NSF and other federal agencies to provide facilities and support for a wide range of studies in the atmospheric and related sciences. Research activities across NCAR will increase by $4.02 million, or about 4.7 percent, enabling continued research and facility operations at approximately the same level as FY 2007.

Stewardship	+$2.34

GEO will increase support for administrative activities necessary to enable NSF to achieve its strategic goals. This includes the cost of Intergovernmental Personnel Act appointments and contractors performing administrative functions.

Subtotal, Changes	+$47.15

FY 2008 Request, GEO…………………………………………………………………….……...….$792.00

GEO Facilities Funding
(Dollars in Millions)

Facilities	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Academic Research Fleet	$76.21	$97.70	$97.60	-$0.10	-0.1%
Regional Research Vessel	*3.63*	*15.10*	*14.00*	*-1.10*	*-7.3%*
RHOV Construction (R/V Alvin Replacement)	*8.63*	*5.10*	*3.00*	-2.10	*-41.2%*
R/V Langseth Construction (R/V Ewing Replacement)	*1.74*	-	-	-	*N/A*
Ship Operation and Upgrade	*62.21*	*77.50*	*80.60*	*3.10*	*4.0%*
Advanced Modular Incoherent Scatter Radar (AMISR)	7.50	-	-	-	N/A
Alaska Regional Research Vessel (ARRV)	0.03	-	-	-	N/A
EarthScope: USArray, SAFOD, PBO	6.72	11.61	21.61	10.00	86.1%
Incorporated Research Institutions for Seismology (IRIS)	11.41	12.90	11.40	-1.50	-11.6%
Integrated Ocean Drilling Program (IODP)	28.56	4.50	4.64	0.14	3.1%
Nanofabrication (NNIN)	0.49	0.49	0.49	-	-
Ocean Observatories	4.15	8.30	15.10	6.80	81.9%
ODP Facilities	3.63	2.00	-	-2.00	-100.0%
Scientific Ocean Drilling Vessel (SODV)	-	21.30	33.36	12.06	56.6%
NCAR	83.48	85.73	89.75	4.02	4.7%
NAIC	1.69	1.70	1.70	-	-
Total, GEO	$223.87	$246.23	$275.65	$29.42	11.9%

NSF-WIDE INVESTMENTS

In FY 2008, the Directorate for Geosciences 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.

GEO NSF-wide Investments
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Biocomplexity in the Environment	$36.85	$26.11	-	-$26.11	-100.0%
Climate Change Science Program	149.35	157.72	160.72	3.00	1.9%
Cyberinfrastructue	71.35	75.00	75.00	-	-
Human and Social Dynamics	1.35	1.35	1.35	-	-
International Polar Year	-	5.00	5.00	-	-
Mathematical Sciences	7.00	3.53	-	-3.53	-100.0%
National Nanotechnology Initiative	9.00	9.65	9.65	-	-
Networking and Information Technology R&D	14.56	14.56	14.56	-	-

Biocomplexity in the Environment: With the conclusion of this priority area in FY 2007, key components of investment in Biocomplexity in the Environment will be transferred to core programs for continued support. Emphasis on the interaction of human and natural systems will continue. Future directions for key components of this program will be influenced by an external review conducted in early FY 2007.

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. Directly contributing to the Administration's agency-wide R&D priorities, 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. In FY 2008, increased emphasis will be placed on understanding Earth's water cycle, carbon cycle, and past and potential future climate variability and change.

Cyberinfrastructure: Research advances in the geosciences increasingly depend on the presence of underlying cyberinfrastructure to bridge systems and make data interoperable across platforms. Linked to the process of innovation and the ACI, GEO will continue to invest in making computation available to geoscientists through the acquisition and operation of next-generation computational 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, tornados, solar disruptions, etc.) and other natural processes affecting society.

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 the IPY period.

Mathematical Sciences: With the conclusion of this priority area in FY 2007, key components of investment in Mathematical Sciences will be incorporated into a follow-on joint GEO-Math activity currently under development.

National Nanotechnology Initiative (NNI): Nanotechnology is recognized as one of the current frontiers of innovation, and is specifically linked to the ACI. Contributing to NNI, GEO will support studies of natural nanoscale processes in the environment and utilizing nanoscale phenomena as catalysts for environmental remediation.

Networking and Information Technology R&D (NITRD): Within NITRD, an area which explicitly supports the Administration's agency-wide R&D priorities, GEO focuses on the development and enhancement of computational modeling capacity and capability. One flagship activity is the Climate Simulation Laboratory at 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.

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 2006. OMB's definition of competitive, merit-based review, however, 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 (COV), 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 2006, GEO convened COVs for the UCAR and Lower Atmospheric Facilities Section of the ATM Division. COVs also were convened for the Ocean and Marine Geosciences Sections of the OCE Division in 2006 and directorate-wide education and diversity programs in 2007.

The Directorate 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

The FY 2008 Budget Request is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals stated in the FY 2006-2011 Strategic Plan. These goals provide an overarching framework for progress in fundamental research and education and facilitate budget and performance integration.

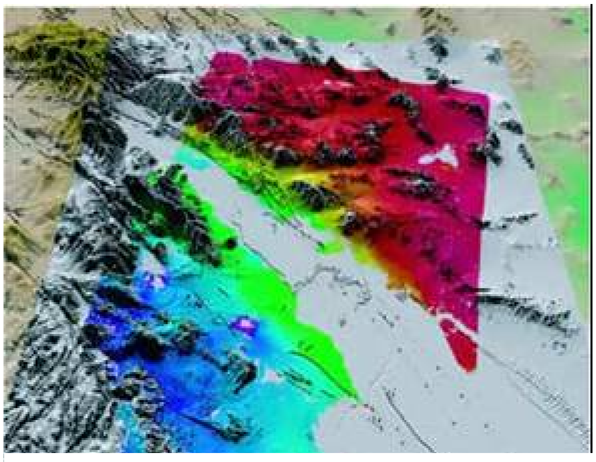
Geosciences
By Strategic Outcome Goal
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Discovery	$387.43	$396.97	$412.26	$15.29	3.9%
Learning	29.55	31.39	31.39	-	-
Research Infrastructure	281.06	311.08	340.60	29.52	9.5%
Stewardship	5.91	5.41	7.75	2.34	43.3%
Total, GEO	$703.95	$744.85	$792.00	$47.15	6.3%

Totals may not add due to rounding.

GEO will continue its commitment to education, training, and increasing diversity in FY 2008. The FY 2008 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 and the Integrated Ocean Drilling Program.

Recent Research Highlights

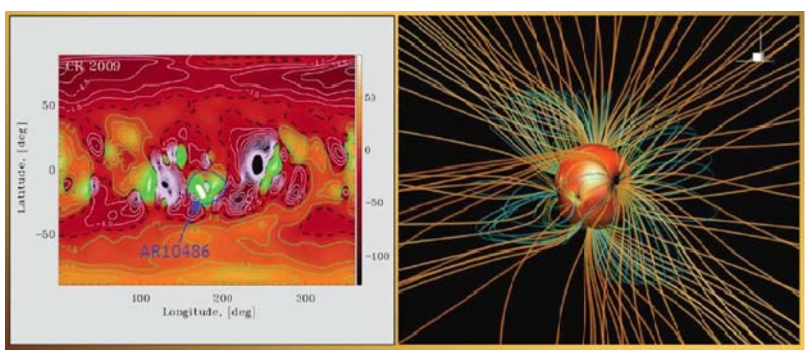


Surface deformation from radar interferograms across the Salton Sea shows movement of the San Andreas fault. Digital terrain from Shuttle Radar Topography Mission. *Credit: Yuri Fialko.*

► **San Andreas Fault Set for the 'Big One:'** Yuri Fialko of the Scripps Institution of Oceanography at the University of California, San Diego, the recipient of a GEO CAREER award in 2004, has produced a new depiction of the earthquake potential of the San Andreas Fault's southern, highly populated section. The new study indicates that the fault has been stressed to a level sufficient for an earthquake of magnitude seven or greater, and that the risk of a large earthquake in this region may be increasing faster than researchers had believed.

Fialko used remote sensing techniques like GPS and satellite radar data, geologic records, and seismic data to observe strain build-up along the southern part of the fault. He found evidence that the southern San Andreas has accumulated about six to eight meters of slip "deficit." If released at one time, this would result in a Magnitude 8 earthquake, roughly the size of the 1906 San Francisco earthquake. Fialko also found that the two sides of the fault, the North American tectonic plate and the Pacific plate, exhibit different structural characteristics. The Pacific plate is more rigid than its neighbor. This research is important not only for long-term hazard planning in the densely populated region of Southern California, but also for providing new, precise analyses and methods to help earthquake scientists discover how faults operate. (EAR).

► **Improved Solar Forecasting Through Advanced Simulations of the Sun:** Forecasting hazards posed by the "weather" in space can be as important — and as difficult — as forecasting thunderstorms, tornadoes and hurricanes on the ground. The highly energetic charged particles emitted by the Sun can endanger astronauts, damage the electronics on satellites and planetary probes, increase the radiation exposure of crews and passengers in high-altitude aircraft, and even affect electrical systems on the Earth's surface.



Map of the radial component of the Sun's magnetic field preceding the CME (coronal mass ejection) of Oct 28, 2003. (Above Left); Computed steady-state coronal magnetic field for the same date, with solar wind flow vectors.(Above Right) The CME later erupted from the active region labeled "AR10486" in blue on the left. *Credit: Ilia Roussev, University of Hawaii.*

Now, however, Ilia Roussev at the University of Hawaii has developed a computer model that could improve space weather forecasts significantly. Based on a well-established, but highly-complex physical theory known as magnetohydrodynamics, Roussev's model accurately simulates the flares and other solar eruptions that emit the high-energy particles. (ATM).

► **Improving Hurricane Modeling by Including Ocean Waves**: NSF-funded research at the University of Rhode Island has greatly improved scientists' understanding of how waves at the ocean's surface influence the formation of hurricanes.

The role of waves has long been one of the main uncertainties in modeling tropical hurricanes and their resulting storm surge.

The advance provided by the new research is significant, especially for strong hurricanes. When the new model of wave influence was tested on a simulation called the Geophysical Fluid Dynamics Laboratory/University of Rhode Island hurricane model, the hurricane tracking estimates improved by five to seven percent and the hurricane intensity prediction improved by up to 20 percent. The results were so on-target that they will be incorporated in the National Weather Service's operational version of the model, and will be used by the National Hurricane Center in real-time hurricane forecasts. (OCE).

► **Finding and Keeping Kids in the Earth Science Pipeline from 6th Grade to Post-college:** Researcher Alan Smith and his team at Cal State San Bernadino have completed an ambitious project to recruit and retain underrepresented ethnic groups in the earth sciences from 6th grade to post-college. In an initial survey asking minority children why they were not majoring in geology, the top reasons were lack of exposure to the geosciences and lack of knowledge about geoscience careers.

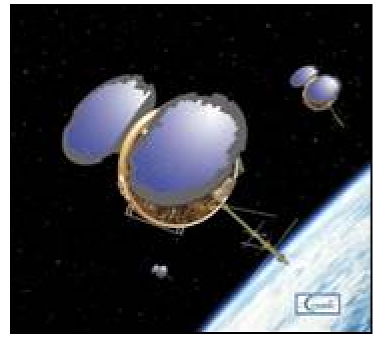
Shoe-box modeling of plate tectonics.
Credit: Sally McGill

Armed with these results, the team conducted 169 outreach sessions over a three-year period that involved more than 12,000 contact hours with 5,700 students. Most students were middle- or high-school students, and three quarters were from underrepresented groups in the geosciences (52 percent were Hispanic, 13 percent African American, five percent Native American, and 4 percent Pacific Islander).

Group activities included hikes to the San Andreas fault and hands-on exercises related to plate tectonics and earthquakes. Hands-on activities were modified to enhance students' familiarity with the scientific method. Students began by making observations from and asking questions about maps of the Earth. One of the observations they often noted was that the coastlines of Africa and South America look like they would fit together. They also noticed the mid-ocean ridges and trenches on the sea floor. A computer animation of world seismicity was shown so that students could make observations about where earthquakes occur.

Another activity was a bi-annual Global Positioning System (GPS) campaign. This campaign allowed students to work with scientists and use state-of-the-art GPS receivers to precisely determine the location of benchmarks on both sides of the San Andreas and San Jacinto faults. From these measurements, the students determined the bending of the tectonic plates that will eventually lead to slip along these faults as major earthquakes. Students worked with scientists to interpret the GPS data in terms of how fast the faults were slipping. Results were presented at meetings of the American Geophysical Union and the Southern California Earthquake Center. The data were also shared with the Southern California Earthquake Data Center (www.scecdc.scec.org) for use by other scientists around the country and around the world. (ICER).

► **New Satellites Enhance Weather and Climate Change Forecasts:** A globe-spanning constellation of six satellites, expected to improve weather forecasts, monitor climate change, and enhance space weather research headed into orbit in April 2006. The low-orbiting satellites (called COSMIC) will be the first to provide atmospheric data daily in real time over thousands of points on Earth for both research and operational weather forecasting. The satellites will measure the bending of radio signals from the U.S. Global Positioning System (GPS) as the signals pass through Earth's atmosphere.



A constellation of satellites, called COSMIC, will transmit new information for studies of weather and climate. Credit: *University Corporation for Atmospheric Research/National Center for Atmospheric Research.*

Temperature and water vapor profiles derived from the GPS data will help meteorologists observe, research, and forecast hurricanes, typhoons, and other storm patterns over the oceans. The stability, consistency, and accuracy of the measurements will provide critical new information to scientists quantifying long-term climate change trends. (ATM).

► **A Transformation in Hydrologic Science:** Three NSF-funded hydrologists have made great progress in understanding what happens to a river system when it is modified, whether by engineered works or by stream restoration.

- Heidi Nepf (MIT) has applied the principles of physics to determine how vegetation on the channel beds and stream banks affects sedimentation, nutrient transport, and riverbank stability, both during normal flow and flood stage.
- Ellen Wohl (Colorado State) has determined the role of woody debris in shaping river channels. This information places river restoration strategies in the context of a historical view of a river channel, and allows scientists and environmental managers to balance the benefits of river restoration strategies against the benefits of reducing flood potential.
- Peter Kitanidis (Stanford) has integrated these elements. His models of river flow and transport through pools and riffles incorporates riverbed characteristics and flow interactions with banks and in-river obstacles.

In combination, the three hydrologists' work will help engineers, ecologists, and water resource managers balance engineered performance against the quality of the natural system, and will help society as a whole mitigate environmental degradation and extreme events in river systems around the world. (EAR).

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 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Senior Researchers	4,120	4,200	4,300
Other Professionals	2,924	3,000	3,100
Postdoctorates	573	600	650
Graduate Students	2,307	2,300	2,400
Undergraduate Students	4,342	4,500	4,600
Total Number of People	14,266	14,600	15,050

GEO Funding Profile

	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Statistics for Competitive Awards:			
Number	1,424	1,500	1,600
Funding Rate	31%	31%	31%
Statistics for Research Grants:			
Number of Research Grants	1,113	1,100	1,200
Funding Rate	28%	28%	28%
Median Annualized Award Size	$110,394	$111,000	$113,000
Average Annualized Award Size	$148,499	$149,000	$155,000
Average Award Duration, in years	3	3	3

ATMOSPHERIC SCIENCES $240,840,000

The FY 2008 Request for the Division of Atmospheric Sciences (ATM) is $240.84 million, an increase of $13.99 million, or 6.2 percent, over the FY 2007 Request of $226.85 million.

Atmospheric Sciences Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Atmospheric Sciences Research Support	132.65	141.12	151.09	9.97	7.1%
National Center for Atmospheric Research	83.48	85.73	89.75	4.02	4.7%
Atmospheric Sciences	**$216.13**	**$226.85**	**$240.84**	**$13.99**	**6.2%**
Major Components					
Research and Education Grants	96.67	103.12	111.39	8.27	8.0%
Centers Programs					
Center for Integrated Space Weather Modeling	4.00	4.00	4.00	-	-
Center for Atmospheric Process Modeling	-	4.00	4.00	-	-
Facilities					
National Center for Atmospheric Research (NCAR)	83.48	85.73	89.75	4.02	4.7%
Research Resources and Infrastructure	31.98	30.00	31.70	1.70	5.7%

About ATM:

The North American continent is subject to some of the world's most severe weather. As well as the impacts of winter Pacific storms, tropical storms over the Atlantic Ocean, Caribbean Sea, or Gulf of Mexico can develop into fierce hurricanes that pound coastal regions, 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.

ATM supports a diverse portfolio of research, education, and infrastructure activities. Approximately 42 percent of the annual budget of ATM is used to support individuals and small groups of researchers, with approximately 20 percent of the total division budget being available to support new research grants.

ATM priorities for FY 2008:

- 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 Climate Change Science Program, the U.S. Weather Research Program, the National Space Weather Program and cooperative international science programs.

Changes from FY 2007

- Research and education grants and centers increase by \$8.27 million, to a total of \$111.39 million, and include:
  - an increase of \$2.0 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 \$4.27 million in other disciplinary programs.

- Facilities increase by \$5.72 million to a total of \$121.45 million, and include:
  - an inflationary increase of \$4.02 million for NCAR; and
  - an increase of \$1.70 million for operations of AMISR and other atmospheric research facilities.

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

EARTH SCIENCES $163,300,000

The FY 2008 Request for the Division of Earth Sciences (EAR) is $163.30 million, an increase of $11.0 million, or 7.2 percent, over the FY 2007 Request of $152.30 million.

Earth Sciences Funding

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Earth Science Project Support	105.77	115.90	126.90	11.00	9.5%
Instrumentation and Facilities	34.58	36.40	36.40	-	-
Earth Sciences	**$140.35**	**$152.30**	**$163.30**	**$11.00**	**7.2%**
Major Components:					
Research and Education Grants	92.92	98.63	101.01	2.38	2.4%
Centers Programs					
Sustainability of Semi-Arid Hydrology and Riparian Areas	3.29	3.32	3.32	-	-
National Center for Earth-Surface Dynamics	3.38	3.36	3.48	0.12	3.6%
Facilities					
Incorporated Research Institutions for Seismology (IRIS)	11.41	12.90	11.40	-1.50	-11.6%
EarthScope Operations	6.72	11.61	21.61	10.00	86.1%
Other Earth Sciences Infrastructure	22.63	22.48	22.48	-	-

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 supports a diverse portfolio of research, education, and infrastructure activities. Approximately 64 percent of the annual budget of EAR is used to support individuals and small groups of researchers, with approximately 36 percent of the total division budget being available to support new research grants.

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 Teragrid, 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 2008:

- 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 2007:

- EAR will continue to increase by $10.0 million the funding of Operations and Maintenance of the EarthScope facility,
- Funds of $1.0 million will be invested in Critical Zone Observatories, coordinated field installations aimed at elucidating the interactions of natural systems in the Earth's near surface environment.
- A $1.50 million reduction in funding for IRIS will shift funds to other earth science research activities.

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

The FY 2008 Request for the Division of Innovative & Collaborative Education and Research (ICER) is $58.57 million, level with the FY 2007 Request.

Innovative and Collaborative Education and Research Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Innovative & Collaborative Education and Research	**$58.37**	**$58.57**	**$58.57**	-	-
Major Components:					
Research and Education Grants	53.13	53.17	53.17	-	-
International Collaborations	5.24	5.40	5.40	-	-

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.

ICER supports a diverse portfolio of research and education activities. Approximately 60 percent of the annual budget of ICER is used to support individuals and small groups of researchers, with approximately 40 percent of the total division budget being available to support new research grants.

ICER Priorities for FY 2008:

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 2008, resources will be targeted at increasing the diversity of the geoscience workforce and enhancing the linkages between existing 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 Environmental Research and Education and aims to increase fundamental understanding of the interrelation of physical, chemical, geological, hydrologic, atmospheric, and biological processes that comprise Earth's natural systems. Examples include highly interdisciplinary programs that involve several NSF directorates, such as solicitations on Coupled Natural and Human Systems and Human and Social Dynamics, particularly regarding decision making and uncertainty.

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 2007:

No changes in programmatic support are requested from the FY 2007 level.

OCEAN SCIENCES $329,290,000

The FY 2008 Request for the Division of Ocean Sciences (OCE) is $329.29 million, an increase of $22.16 million, or 7.2 percent over the FY 2007 Request of $307.13 million.

Ocean Sciences Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Ocean Section	107.89	114.62	118.82	4.20	3.7%
Integrative Programs Section	105.77	112.37	117.33	4.96	4.4%
Marine Geosciences Section	75.43	80.14	93.14	13.00	16.2%
Ocean Sciences	**$289.09**	**$307.13**	**$329.29**	**$22.16**	**7.2%**
Major Components:					
Research and Education Grants	161.12	151.76	158.66	6.90	4.5%
Long-term Ecological Research Centers	3.13	3.50	3.50	-	-
Centers Program					
Center for Coastal Margin Observation/Prediction	-	4.00	3.96	-0.04	-1.0%
Facilities					
Academic Research Fleet	76.21	97.70	97.60	-0.10	-0.1%
Integrated Ocean Drilling Program (IODP)	28.56	25.80	38.00	12.20	47.3%
Other Ocean Sciences Infrastructure	20.07	24.37	27.57	3.20	13.1%

About OCE:

Research, education, and infrastructure funded by OCE addresses the central role the oceans play in an ever-changing Earth and as a strategic resource for the nation. OCE supports research that combines the chemistry, physics, and biology of the oceans today to better understand the natural processes involved with topics such as: CO_2 exchange between the oceans and atmosphere and its implications for ocean acidification; air-sea exchange of heat and its consequences for major storms and hurricanes; impact of natural and anthropogenic change on food webs and fishery stocks; and the role of the oceans in human health. Geologic studies of the ocean margins and sub-seafloor, incorporating biology, chemistry, and physics, investigate past ocean and climate conditions; the natural hazards associated with earthquakes, volcanic eruptions and tsunamis; the natural cycles of water and CO_2 in the deep Earth; and the biological strategies used in the deep biosphere. The strongly interdisciplinary nature of ocean sciences and the increasingly sophisticated remote sensing and visualization of the ocean and seafloor now available provide a strong framework for both formal and informal education. Ocean science requires access to the sea; OCE supports research vessels, manned and unmanned deep diving submersibles, and a wide range of technologically advanced sensors and observational instrumentation.

The OCE portfolio has three highly integrative programmatic areas of support:

- OCE research grants include awards to individual scientists, to small collaborative groups, and to several large coordinated projects involving international partners and major shared-use facilities.
- OCE education grants support graduate 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 for OCE.

- 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.

OCE supports a diverse portfolio of research, education, and infrastructure activities. Approximately 52 percent of the annual budget of OCE is used to support individuals and small groups of researchers, with approximately 34 percent of the total division budget being available to support new research grants.

OCE Priorities for FY 2008:

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

- The Ocean Observatories Initiative (OOI) remains a high priority to address the need for sustained time-series observations of the many highly dynamic and complex ocean processes and characteristics within the ocean and below the seafloor. OOI deployments will provide power and two-way communication to re-configurable arrays of ocean sensors. Funding increases by $6.80 million in FY 2008.
- The Integrated Ocean Drilling Program (IODP) is an international partnership of scientists, research institutions, and agencies using ocean drilling to explore the evolution and structure of Earth and its oceans as recorded in the ocean basins. The program will increase by $12.20 million in FY 2008, with three platforms for drilling, including the US contribution of the Scientific Ocean Drilling Vessel.
- A NSF Science and Technology Center (STC) for Coastal Margin Observation and Prediction will undertake its first full year of operations, to create 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.
- Community driven numerical modeling systems in marine geology and oceanography are developing integrated hardware and software packages to enable scientists to better combine observations and theory, providing a framework for scientific advances and their application to national needs.
- OCE will build on past investments to contribute to the four near term priorities in the national Ocean Research Priorities Plan: comparative analysis of marine ecosystems; the Atlantic meridional overturning circulation and its role in abrupt change; development of sensors for ecosystem observation; and the effects of persistent forcing and extreme events on coastal environments.
- COSEE partnerships foster interactions among research institutions, formal education organizations, and informal education providers like museums to deliver high-quality education programs that integrate research to promote a deeper public understanding of the oceans, their influence on quality of life and national prosperity, and their growing need for work-force development.
- Providing scientists with access to the sea via modern infrastructure is essential. Building upon recommendations of the National Academy of Sciences and the Federal Oceanographic Facility Committee (FOFC), several projects will continue, including the construction of regional-class research vessels to replace aging and less capable ships.

Changes from FY 2007:

- Research and education grants increase by $6.90 million, to a total of $158.66 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 research infrastructure increases $15.30 million, to a total of $163.17 million, with increases targeted at the Integrated Ocean Drilling Program and the Ocean Observatories Initiative.

MATHEMATICAL AND PHYSICAL SCIENCES $1,253,000,000

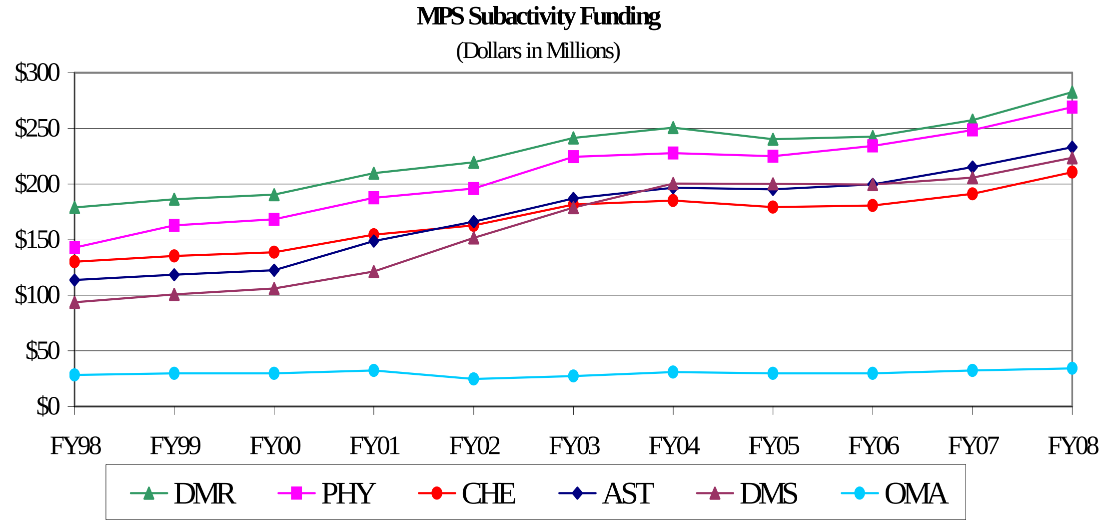
The FY 2008 Budget Request for the Mathematical and Physical Sciences (MPS) Directorate is $1.25 billion, an increase of $102.70 million, or 8.9 percent, over the FY 2007 Request of $1.15 billion.

Mathematical and Physical Sciences Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Astronomical Sciences	$199.75	$215.11	$232.97	$17.86	8.3%
Chemistry	180.70	191.10	210.54	19.44	10.2%
Materials Research	242.59	257.45	282.59	25.14	9.8%
Mathematical Sciences	199.52	205.74	223.47	17.73	8.6%
Physics	234.15	248.50	269.06	20.56	8.3%
Multidisciplinary Activities	29.9	32.40	34.37	1.97	6.1%
Total, MPS	$1,086.61	$1,150.30	$1,253.00	$102.70	8.9%

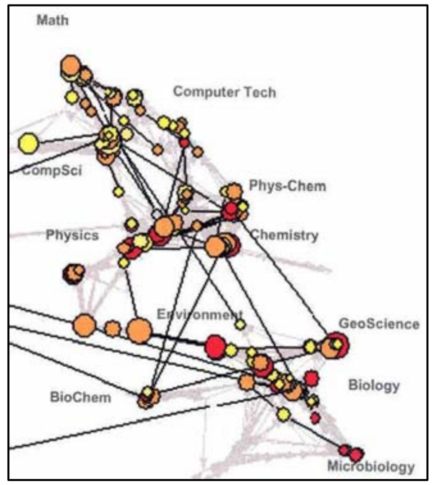
Totals may not add due to rounding.

The Mathematical and Physical Sciences Directorate advances innovation and competitiveness through its portfolio of investments in support of fundamental research, facilities and instruments that enable discovery and development, and integrated education and research activities that contribute to enhancing the breadth and depth of the science and engineering workforce. The portfolio includes MPS participation in NSF-wide and interagency research and education, and emphasizes discovery, innovation, and learning aligned with NSF priorities and the American Competitiveness Initiative (ACI).



RELEVANCE

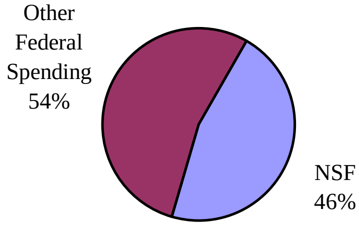
MPS-supported research advances the frontiers of knowledge, drives technological innovation, and stirs the imagination. It involves cutting-edge basic research in areas ranging from the behavior and control of molecules at the nanoscale to the complexity of their chemical interactions in materials and life processes; from the structure and evolution of the universe to the fundamental particles and processes of matter; from developing new mathematical structures and theories to transforming them into models of natural and human-made systems that connect to computation, experimentation, and observation. MPS research spans the full range of spatial and temporal scales accessible to human investigation, and it brings the perspective and methodologies of the physical sciences to exploring complex biological systems, human and social dynamics, sustainable energy, and the environment. Increasingly, it 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.



Detail from a "map" of topics in the 820,000 most-referenced journal articles of 2003 reveals converging interests and connections. *Credit: Kevin W. Boyak, Sandia National Laboratories., Richard Klavans, SciTech Strategies, Inc.*

MPS-supported research in the physical and mathematical sciences plays a major role in innovation and competitiveness. While advancing the scientific frontiers in MPS disciplines, MPS investments also provide the knowledge base for advances in other technical, engineering, and health-related disciplines, as well as for industrial and technological innovation and national security. Exploration of the fundamental properties of matter, the complex laws governing chemical reactivity, the behavior and control of molecules at the nanoscale, the structure and evolution of the universe, and the mathematical ideas underlying our ability to formulate and solve problems have played a fundamental role in the technological leadership of the United States and in maintaining its health, economy, defense, and homeland security. This research sparks 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. Consistent with ACI goals and objectives, MPS is increasingly engaged in enabling international partnerships to foster cooperation, build global research capacity, and advance the frontiers of the mathematical and physical sciences.

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

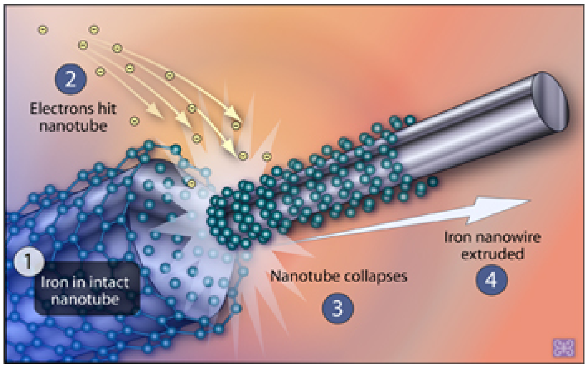


MPS provides about 46 percent of federal funding for basic research at academic institutions in the mathematical and physical sciences and serves as the federal steward for ground-based astronomy and gravitational physics. MPS provides about 43 percent of the federal support for academic astronomy; in chemistry, about 40 percent; in physics, approximately 36 percent; in materials research, approximately 55 percent; and in mathematics, more than 66 percent. MPS collaborates with other disciplines within NSF and partners with other agencies, the private sector, and other nations in exploring areas, such as nanoscale science and engineering, the physics of the universe, 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 transformative 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 that infrastructure. MPS infrastructure investments range from portable instruments to international facilities with hundreds of users and include 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. MPS-supported activities link both formal and informal education programs to forefront research activities in the U.S. and other countries.

ACI places high priority on enhancing the strength of the U.S. technical and instructional workforce. To ensure a diverse, internationally competitive, and globally-engaged workforce of scientists, engineers, and well-prepared citizens, MPS will make selected investments in all phases of education – from K-12 through undergraduate, graduate, postgraduate, and continuing education, as well as outreach activities. MPS is emphasizing activities connecting undergraduate education with research, with a new focus on first and second-year college students, taking advantage of the larger numbers and greater diversity in this pool and aiming toward increasing the science and engineering workforce. The MPS divisions work through partnerships of all types in order to achieve high priority NSF objectives. 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.



Electrons hitting an iron carbide-filled carbon nanotube cause it to contract and extrude material.

According to an international team of scientists, bombarding a carbon nanotube with electrons causes it to collapse with such incredible force that it can squeeze out even the hardest of materials. Pressures within the tubes reach one-tenth the crushing force in the Earth's core. The researchers suggest that carbon nanotubes can act as minuscule metalworking tools, offering the ability to process materials as in a nanoscale jig or extruder. *Credit: Zina Deretsky, NSF*

NSF is the principal source of federal support for strengthening Science, Technology, Engineering, and Mathematics (STEM) education across all levels and is uniquely positioned to provide leadership for the Nation due to its focus on STEM education research. These programs are responsive to MPS's mission and goals, increase American competitiveness in the global economy, and support NSF's underlying strategy of integration of research and education.

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

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

Astronomical Sciences Division (AST) +$17.86

Increased funding for research grants and instrumentation, with emphasis on addressing scientific priorities articulated in the National Research Council's "Astronomy and Astrophysics for the New Millennium" and those of the interagency Physics of the Universe (POU) activity undertaken in partnership with the Physics Division, DOE and NASA; cyberscience and cyberinfrastructure, including implementation of a national virtual observatory in partnership with NASA and the development of tools to handle large data sets; Gemini Observatory operations and instrumentation and continuing ramp-up of early operations for Atacama Large Millimeter Array (ALMA); and strategic public-private partnerships, including design for the Giant Segmented Mirror Telescope.

Chemistry Division (CHE) +$19.44

Increased funding for a strong, flexible grants program that advances the frontiers of chemical sciences, emphasizing areas such as complex nanoscale systems and the molecular basis of life processes, design and synthesis of single-molecule electronic devices aimed at the challenge of Moore's Law[1], and sustainability in energy and environment; expansion of the Chemical Bonding Centers program which incorporate ACI-related priorities; cyber-enabled discovery and innovation in chemistry; instrumentation development; and broadening participation in the workforce through investments in new faculty and undergraduate participation in research.

Division of Materials Research (DMR) +$25.14

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, complex systems (including biomaterials), materials aspects of computational discovery and innovation, and fundamental research addressing Science Beyond Moore's Law that encompasses novel materials and phenomena required for the future development of entirely new computational and communications technologies; broadening participation in materials research through research and education partnerships; expanded support for Materials Research Science and Engineering Centers; maintaining support for world-class user facilities while enabling the development of future instrumentation; and continuing strong support for international collaborations and partnerships in materials research.

Division of Mathematical Sciences (DMS) +$17.73

Increased funding for fundamental mathematical and statistical sciences including activities that strengthen the development of underlying concepts and ideas as well as those that enable effective partnering with other science and engineering disciplines; cyber-enabled discovery and innovation that incorporate modeling, algorithms, and simulation to provide new ways of obtaining insight into the nature of complex phenomena, as well as exploring the challenges of "Moore's Law;" enhancing the portfolio of collaborations involving institutes and networks; and enhancing the strength of the workforce through discovery-based experiences for undergraduates.

[1] Moore's Law: In 1965 the co-founder of Intel, Gordon E. Moore, predicted that computing power, based on semiconductor integrated circuits, would double every 18 to 24 months, a prediction that has had staying power for over 40 years.

Physics (PHY) +$20.56

Increased funding to advance the frontiers of physics, with emphasis on elementary particle physics, biological physics, and the interagency Physics of the Universe activities with the Division of Astronomical Sciences, DOE, and NASA; cyberinfrastructure and cyber-enabled discovery; expanded resources for the design and development of next-generation instrumentation and facilities; and education and outreach activities, including broadening participation in the research community. Early operations for IceCube will begin; enhanced support for operations at NSCL will take advantage of the recent upgrade; reduced support for operations and advanced detector R&D at LIGO reflect initiation of AdvLIGO as an MREFC project.

Office of Multidisciplinary Activities (OMA) +1.97

Increased funding for collaborative activities aimed at initiating innovative cross-disciplinary research and connecting fundamental ideas to innovative technologies, as well as broadening participation in and informing the public about MPS discipline

Subtotal, Changes +$102.70

FY 2008 Request, MPS........………………………………………………………………..$1,253.00

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

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

<u>Discovery Research for Innovation</u> +$55.95

Disciplinary and Interdisciplinary Research ($45.95 million).

MPS assigns high priority to providing strong support of individual investigators and small groups pursuing fundamental research across all disciplines of MPS. Support of the core discovery mission is paramount to meeting science opportunities in MPS disciplines, to maintaining a competitive workforce in these areas, and to enabling a vital interdisciplinary effort. Extraordinary research opportunities, as well as opportunities to connect with ACI and NSF priorities, exist in all of the MPS sciences. Within the context of disciplinary and interdisciplinary research, MPS emphasis areas interact with one another, with NSF and Administration priorities, and with the overall portfolio in synergistic fashion, reflecting commonalities in the underlying complex physical systems. Some specific emphases include:

- *Physical Sciences at the Nanoscale.* MPS activities as part of the National Nanotechnology Initiative will expand with emphases on investigating how to control nanoscale objects, features, and devices at the atomic level of precision, understanding the impact of quantum phenomena in the nanoscale regime, and connecting quantum and nanoscale phenomena predictively across length and time scales with the macro properties of materials. Nanoscale activities are key components of ACI, critical for the technologies of the future in communications, energy, and other fields.

- *Science beyond "Moore's Law"*. Moore's Law is likely to reach physical limits within 10 to 15 years unless major breakthroughs are made in molecular and nanoscale science and engineering. To go *beyond* Moore's Law will require entirely new science and technologies, as well as new algorithms and new conceptual frameworks for computing. MPS will focus on approaches to the science beyond Moore's Law involving quantum control, carbon-based systems, molecular electronics, spintronics, and single electron transistors. Revolutionizing the size, power, and speed of computers and other electronic and photonic devices has the potential for enormous economic impact and is perfectly aligned with ACI goals.

- *Physics of the Universe (POU)* and *Elementary Particle Physics (EPP).* A series of staggering results describing the mysteries of dark matter and dark energy in the universe and linking our understanding of the smallest elementary particles to the cosmos in which they formed has captured the scientific imagination. POU is 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. POU complements the traditional approach to EPP based on accelerator physics per the recent National Research Council report, *EPP2010*.

- *Complex Systems.* All aspects of the physical sciences deal with complex systems that cross multiple scales of space and time. Physical science-based approaches to exploring complex systems, including computational modeling and simulation, provide new tools for other fields, while the frontiers of these fields provide concrete examples to test predictive capabilities in more easily observed situations. This synergy has the promise for creating innovative new technologies across science and engineering that are important to ACI objectives. The MPS portfolio includes expanded activities in life science areas such as the molecular bases of life processes, biomaterials, biological physics, and neuroscience, as well as fields as diverse as the geosciences (e.g., water systems, natural disasters), engineering, and the social sciences.

- *Fundamental Mathematical and Statistical Sciences*. This is a core component as well as a central enabler of the ACI, both strengthening the mathematical and statistical sciences and enabling effective partnering with other disciplines within NSF and with other agencies. Additional support will be provided to the mathematical science institutes that bring together mathematical scientists, often with researchers in other disciplines, to identify exciting new areas of research. These connections also serve as important mechanisms for broadening participation by members of under-represented groups and institutions.

- *Sustainability*. Sustainable use of energy and natural resources requires new approaches to synthesis of chemicals and materials. The urgent need to produce commodity chemicals, not from petroleum but from carbon-neutral sources, such as bio-renewable materials, is recognized world-wide. Understanding environmental processes from a molecular point of view can lead to scalable, cyber-enabled models that permit effective environmental decision-making. These efforts are critical to the future of energy technologies, which is a high priority for ACI.

Cyber-enabled Discovery and Innovation (CDI) ($10.0 million).

Modeling, algorithms, software, and simulation are essential research components in all MPS disciplines as are virtual computing networks accessing common data bases and analytic tools. Examples include the synthesis and characterization of new molecular systems; the prediction and discovery of new materials and new states of matter; the creation, manipulation, and control of quantum mechanical states in solid and condensed states of matter; the development of mathematical structures to describe complex, multi-scale networks as typified by the internet; and the creation of visualization techniques for both sparse and dense data. MPS will join other directorates in achieving the CDI objective of developing a new generation of computation based discovery concepts and tools to deal with complex, data-rich, and interacting systems, creating synergy with related activities in Cyberinfrastructure such as development of the global computing GRID, and enhancing the government-wide Networking and Information Technology Research and Development (NITRD) effort.

Preparing the Workforce of the 21st Century +$10.52

Creating a strong science and engineering workforce for the future is a centerpiece of the ACI investment, and MPS disciplines are key elements of workforce preparation. MPS will focus on strengthening existing programs that reach different career levels, from undergraduates through early faculty positions. Discovery-based experiences for undergraduates will continue to be a priority. Emphases include broadening participation through increased funding to promote inclusion of women and underrepresented minorities as participants. In addition to the activities called out below, MPS embeds preparation of the workforce and broadening participation in all aspects of its activities, with centers and facilities providing particularly rich environments for these activities.

- *CAREER* and *Postdoc Programs ($5.06 million).* ACI calls for more support for young investigators. The CAREER program is the primary mechanism for jump-starting junior faculty in research and education, while postdoctoral programs enable young scientists and engineers to prepare themselves for faculty positions.

- *Undergraduates ($1.0 million).* MPS will increase support for programs designed to enhance the educational and career opportunities for undergraduate students, with an increasing emphasis on students in the first two years so as to broaden participation and increase the number of majors, through Computational Science Training for Undergraduates in the Mathematical Sciences.

- *Research Experiences for Teachers ($130,000)* MPS continues support for the Research Experiences for Teachers program. This program is designed to enhance the professional development of K-12 science educators through research experience focused on emerging frontiers of science as a mechanism for integrating new knowledge into the classroom.

- *Research Partnerships for Diversity ($4.33 million).* Additional support for the Partnerships for Research and Education in Materials (PREM) and similar activities across MPS is expected to enhance educational and career opportunities for graduate and undergraduate underrepresented minorities. Such awards are made to minority institutions to support research, education, and institutional infrastructure through partnering with MPS-supported centers and facilities.

- *ACI Fellows.* MPS will pilot an ACI fellows activity that will link undergraduate and graduate education, postdoctoral research, and early faculty experience in areas of particular relevance to ACI, including development of instrumentation, nanotechnology, cyber discovery, quantum science, energy security, and sensor development. Key elements will be (1) transition across elements of the education and career ladders in science and engineering, and (2) connection between fundamental research and innovation. In the pilot year, MPS will use field-specific formats, aiming to move forward with an MPS-wide activity in FY 2009 and to share experiences across NSF. The pilot will draw on a combination of funds from discovery research and workforce preparation.

<u>Transformational Facilities and Infrastructure</u> +$23.87

MPS will increase support for new and emerging facilities and for instrumentation development, including design and development of future facilities, cyberinfrastructure, and mid-scale projects. Investment in these "tools of science" – facilities and instruments that enable discovery and development – are not only transformative for the science of the MPS disciplines, but also enhance capabilities in other fields, fulfilling the explicit goals of ACI.

- *Current Facilities.* Base operations funding for all AST facilities remains near the FY 2007 level, pending a full implementation plan for the recommendations of the AST Senior Review.[2] See the Facilities chapter for additional details. Funding for the Gemini Observatory increases by $500,000 for second-generation instrumentation. The National High Magnetic Field Laboratory will submit a renewal proposal in 2007 for FY 2008 funds. A $2.5 million increase has been allocated to this facility, contingent on the outcome of the renewal process. Funding for the National Superconducting Cyclotron Laboratory increases by $1.9 million to take advantage of its recent upgrade. Funding for operations of the Laser Interferometer Gravity Wave Observatory (LIGO) will decrease by $4.8 million as staff shift to the construction of Advanced LIGO, the MREFC-funded upgrade to the project. See the "MPS Facilities Funding" table below for additional detail.

- *Design and Development.* Planning and design for a deep underground science and engineering laboratory will begin formally in FY 2008 at a total of $6.0 million, building on activities previously supported under Discovery Research. Funding for design and development related to the Giant Segmented Mirror Telescope will continue at $5.0 million.

- *Facilities under Construction.* Funding requested in FY 2008 from the MREFC account for ALMA reflects the new baseline configuration and cost as approved by the National Science Board. Early operations funding for ALMA increases to $8.2 million within the base budget of the National Radio Astronomy Observatory (NRAO). Two other MPS-related projects are in construction phases with funding requested in FY 2008 from the MREFC account. Funding for operations of IceCube is initiated at the $1.5 million level. Construction on Advanced LIGO begins in FY 2008. See the MREFC chapter for details.

- *Cyberinfrastructure.* The portfolio of world-class facilities maintained by MPS for the science and education communities represents past federal investments of over $1.0 billion.

[2] During FY 2006 the Division of Astronomical Sciences chartered a Senior Review of its facilities and instrumentation portfolio. This high-level committee, with extensive consultation within the astronomical community, evaluated the balance among existing facilities. The committee identified lower priority components of the program for which NSF funding could be reduced – either through increased participation of non-Federal sources or through closure – in order to bolster high priority components and invest in new opportunities.

Remote access to these facilities and analyses of the data they generate are aided by increasingly sophisticated cyberinfrastructure. Close interaction between practicing scientists and information technology developers, iterative approaches to software development and deployment, and mechanisms to share best practices are critical in advancing a cyber-enabled science community.

MPS Facilities Funding
(Dollars in Millions)

Facilities	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Cornell Electron Storage Ring (CESR)	$14.62	$14.71	$14.71	-	-
GEMINI Observatory	18.18	20.00	20.50	0.50	2.5%
IceCube	-	-	1.50	1.50	N/A
Large Hadron Collider (LHC)	13.36	18.00	18.00	-	-
Laser Interferometer Gravit. Wave Obs. (LIGO)	31.68	33.00	28.20	-4.80	-14.5%
NCSL (MSU Cyclotron)	17.34	17.60	19.50	1.90	10.8%
Nanofabrication (NNUN/NNIN)	2.77	2.80	2.80	-	-
Nat'l High Magnetic Field Laboratory (NHMFL)	25.74	26.50	29.00	2.50	9.4%
Rare Symmetry Violating Processes (RSVP)	0.99	-	-	-	N/A
Nat'l Astronomy and Ionosphere Center (NAIC)	10.46	10.46	10.45	-0.01	-0.1%
Nat'l Center for Atmospheric Research (NCAR)	1.03	1.12	1.12	-	-
Nat'l Optical Astronomy Observatories (NOAO) [1]	36.91	40.05	43.18	3.13	7.8%
Nat'l Radio Astronomy Observatory (NRAO)	50.74	50.74	52.74	2.00	3.9%
Other MPS Facilities	12.31	12.47	14.97	2.50	20.0%
Total, MPS	$236.13	$247.45	$256.67	$9.22	3.7%

Totals may not add due to rounding.

[1]The NOAO total includes funding for instrumentation programs that build public-private partnerships. In FY 2008, the Telescope System Instrumentation Program is funded at $5 million. The Adaptive Optics Development Program is funded at $1.5 million, level with FY 2007 request, but moves into the disciplinary instrumentation program and so no longer appears in the NOAO budget in FY 2008. The base NOAO/NSO program funding increases by $3.63 million over the FY 2007 request .

- *Instrumentation.* Technology is a powerful driver for innovation in the support of MPS research and education activities. Through research and development of instruments of varying size and complexity (some carried out through public-private partnerships), MPS ensures a continuing stream of enhanced, cutting edge capabilities that can translate into transformative research. FY 2008 will see continuing emphasis on development of unique instrumentation, including sensors and imaging tools, as well as research and development aimed at the facilities of the future.

<u>Centers Programs</u> +$8.14

The Chemical Bonding Center program establishes centers that address long-term basic chemical research problems that are major themes in the ACI. In FY 2008, both phase I and phase II competitions will take place (+$6.0 million). In Materials Research, up to three new centers will be established using new funds and funds generated by phasing out centers through open competition (+$3.5 million). The centers will undertake research and education in materials and condensed matter that are critical to future American competitiveness in the global marketplace. Two NSF Science and Technology Centers begin ramping down activities, a reduction of $1.36 million according to planned funding profiles. See also the "MPS Centers Funding" table below.

MPS Centers Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Chemistry Centers	$1.50	$3.00	$9.00	6.00	200.0%
Materials Centers	53.50	55.70	59.20	3.50	6.3%
Nanoscale Science & Engineering Centers	12.89	12.96	12.96	-	-
Science & Technology Centers	15.51	19.60	18.24	-1.36	-6.9%
Total, MPS	$83.40	$91.26	$99.40	8.14	8.9%

Totals may not add due to rounding

<u>Stewardship</u> +$4.22

MPS will enhance its merit review and oversight processes as part of its pursuit of this NSF goal.

Subtotal, Changes +102.70

FY 2008 Request, MPS ……………………………………………………………….................. $1,253.00

NSF-WIDE INVESTMENTS

In FY 2008, MPS 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 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Biocomplexity in the Environment	$2.63	$1.00	-	-$1.00	-100.0%
Climate Change Science Program	5.45	5.45	5.45	-	-
Cyber-enabled Discovery & Innovation	-	-	10.00	10.00	N/A
Cyberinfrastructure	58.64	63.56	64.56	1.00	1.6%
Human & Social Dynamics	0.50	0.50	0.50	-	-
Mathematical Sciences	70.87	69.26	6.62	-62.64	-90.4%
National Nanotechnology Initiative	158.24	156.42	169.91	13.49	8.6%
Networking and Information Technology R&D	68.93	69.00	76.96	7.96	11.5%

Biocomplexity in the Environment (BE): This priority area is concluding in FY 2007.

Climate Change Science Program (CCSP): MPS investment in CCSP is led by the Division of Chemistry through the U.S. Global Change Research Program. The focus is on studies of atmospheric gases, aerosols, and photochemistry and how these affect climate, as well as sustainability, including green chemistry, water chemistry, and energy.

Cyber-enabled Discovery and Innovation (CDI): MPS will join other directorates in achieving the CDI objective of developing a new generation of computation-based discovery concepts and tools to deal with complex, data-rich, and interacting systems.

Cyberinfrastructure (CI): CI activities at NSF 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.

Human and Social Dynamics (HSD): MPS funding includes support for areas such as interdisciplinary research modeling of 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.

Mathematical Sciences: With the conclusion of this priority area in FY 2007, the FY 2008 funding reflects spending for continuing awards made in prior years. Other components of this investment will return to core programs for continued support.

National Nanotechnology Initiative (NNI): MPS plays an important role, both within NSF and in the interagency working environment, in NNI, investing a total of $169.91 million in FY 2008, an increase of $13.49 million over 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. The Division of Materials Research is the lead division, with significant participation from the Divisions of Chemistry, Physics, and Mathematical Sciences.

Networking and Information Technology Research and Development (NITRD): All MPS divisions support NITRD. The investment is focused in high-end computing infrastructure and applications, with contributions in high-end computing research and development as well as human-computer interaction and information management. Computing in high energy physics and the development of a 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 allocated to projects that undergo external merit review was 86 percent in FY 2006, 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: 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 and include members from institutions and industry. The Committee includes a balanced representation of women, underrepresented minority groups, 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

The FY 2008 Budget Request is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals stated in the FY 2006-2011 Strategic Plan. These goals provide an overarching framework for progress in fundamental research and education and facilitate budget and performance integration.

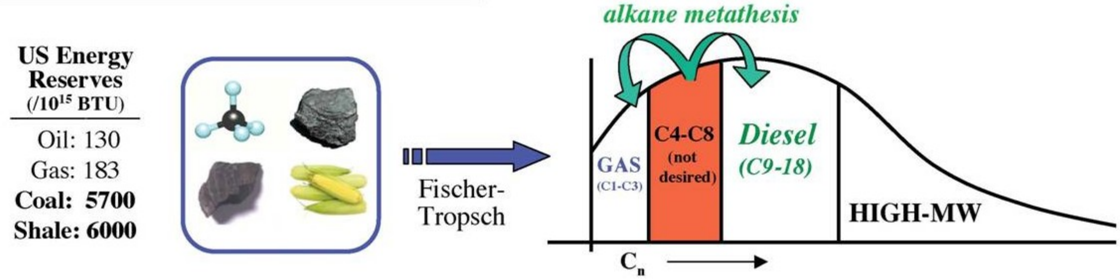
Mathematical and Physical Sciences
By Strategic Outcome Goal
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Discovery	$726.81	$787.98	$861.46	$73.48	9.3%
Learning	72.45	63.77	64.90	1.13	1.8%
Research Infrastructure	277.49	291.42	315.29	23.87	8.2%
Stewardship*	9.86	7.13	11.35	4.22	59.2%
Total, MPS	$1,086.61	$1,150.30	$1,253.00	$102.70	8.9%

Totals may not add due to rounding.
*Iincrease in Stewardship over FY 2007 includes a one-time adjustment in estimates for program-related administration.

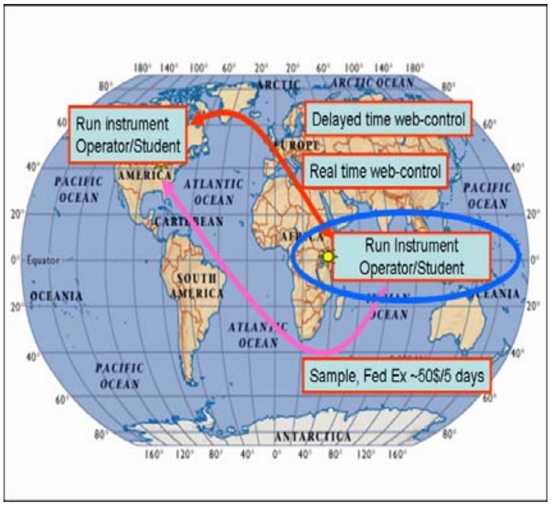
Recent Research Highlights

► **Better Diesel Fuel from Coal:** Coal can be gasified and converted to low molecular weight hydrocarbons through the Fischer-Tropsch process. These small hydrocarbons can then be converted to higher weight hydrocarbons that can be used in diesel fuels. One way of making the desired molecular weight hydrocarbons is to combine the smaller hydrocarbons through a reaction called the olefin



Conversion of coal to diesel by the Fischer-Tropsch process illustrating how alkane metathesis can improve diesel yields. *Credit: Karen Goldberg, University of Washington.*

metathesis reaction. The Chemical Bonding Center for the Activation and Transformation of Strong Bonds has developed an improved catalytic system for the metathesis of alkanes into diesel fuel. This process could improve the economics of the Fischer-Tropsch process and lead to a decreased dependence on foreign oil supplies. It could also enable an increased use of Fischer-Tropsch diesel, which is more environmentally benign than conventional diesel or gasoline. (CHE).



A collaboratory between the University of Dar Es Salaam, Tanzania, Egerton University and Kenya Methodist University of Kenya has been established with Loyola University Chicago. *Credit: Alana Fitch, Loyola University Chicago.*

► **Global Great Lakes Instrumentation Collaboratory:** The Global Great Lakes Instrumentation Collaboratory has established ties between students in East Africa and the Greater Chicago area, allowing them to carry out joint environmental analyses using instruments shared over the Internet. They also share educational resources such as laboratory instructions and curricular material via the Analytical Sciences Digital Library (ASDL) platform.

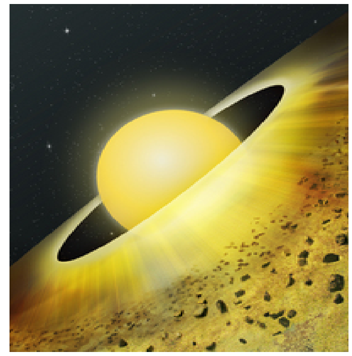
The Collaboratory's participating institutions include Loyola University in Chicago; Egerton University in Njoro, Kenya; Kenya Methodist University; and the University of Dar Es Salaam. The students in Africa prepare water, soil, plant, and fish samples and send them to Loyola University for analysis. They can then access the instruments at Loyola via the Internet, activate them, and monitor progress with a web camera. A database contains the final data which students at the different universities can compare over blogs. Students' learning of instrumentation via remote control is monitored by assessment at strategic points within the entire analytical process. (CHE).

► **Gemini Telescopes Expand Their Capability:** The powerful suite of instruments within each of the Gemini telescopes now follow a queue system, making the structures the most flexibly scheduled ground-based telescopes ever.

Each cluster of imaging and spectroscopic instruments permits Gemini scientists to observe over a remarkably broad spectrum, from the optical through the near-infrared and into the mid-infrared regions of the electromagnetic spectrum. Because of its technique of queue observing, Gemini can use any of these instruments at any point during a night, allowing observers to fine-tune their efforts to the nightly weather and sky conditions. Switching between instruments takes no longer than moving to a new target. This unique and powerful multi-instrument queue brings a new level of efficiency to Gemini operations. (AST).

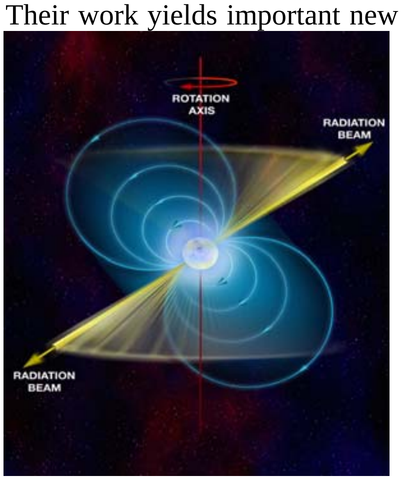
Gemini South telescope at twilight. *Credit: Gemini Observatory.*

► **Astronomers See First Stages of Planet-Building Around Nearby Star:** Future interstellar travelers might want to detour around the star system TW Hydrae to avoid a messy planetary construction site. Researchers at the Harvard-Smithsonian Center for Astrophysics have discovered that the gaseous disk surrounding TW Hydrae holds vast swaths of pebbles extending outward for at least 1 billion miles. These rocky chunks should continue to grow in size as they collide, combine, and eventually coalesce to form planets. The researchers used NSF's Very Large Array to measure radio emissions from TW Hydrae. They detected radiation from a cold, extended dust disk suffused with centimeter-sized pebbles, something no one had seen before. Such pebbles, created as dust collects together into larger and larger clumps, are a prerequisite for planet formation, a process that takes millions of years. (AST).



Artist's conception of a dusty disk around the young star TW Hydrae. *Credit: Bill Saxton, NRAO/AUI/NSF.*

► **Astronomers Discover Fastest-Spinning Pulsar:** Astronomers using the National Science Foundation's Robert C. Byrd Green Bank Telescope (GBT) have discovered the fastest-spinning neutron star ever found, a 20-mile-diameter superdense pulsar whirling faster than the blades of a kitchen blender. Their work yields important new information about the nature of one of the most exotic forms of matter known in the Universe.

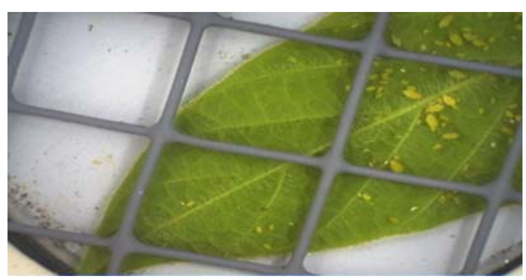


Pulsars are spinning neutron stars that sling "lighthouse beams" of radio waves or light around as they spin. *Credit: Bill Saxton, NRAO/AUI/NSF.*

Pulsars are spinning neutron stars that sling "lighthouse beams" of radio waves or light around as they spin. A neutron star is what is left after a massive star explodes at the end of its "normal" life. With no nuclear fuel left to produce energy to offset the stellar remnant's weight, its material is compressed to extreme densities. The pressure squeezes together most of its protons and electrons to form neutrons; hence, the name "neutron star."

"Neutron stars are incredible laboratories for learning about the physics of the fundamental particles of nature, and this pulsar has given us an important new limit," explained Scott Ransom, an astronomer at the National Radio Astronomy Observatory and one of the collaborators on this work. The great sensitivity of the giant, 100-meter diameter GBT, along with a special signal processor, called the Pulsar Spigot, made possible the discovery of so many millisecond pulsars. "We think there are many more pulsars to be found," Ransom said, "Given that the fast ones are often hidden by eclipses, some of them may be spinning even faster than this new one." (AST).

► **An Eye for Aphids:** A mathematician and his graduate student, both affiliated with the NSF-funded Institute for Mathematics and Its Applications, have developed a new image-analysis technique that can rapidly and accurately count aphids on soybean leaves.



A sample image of aphids on a soybean leaf. Researchers developed an efficient system to distinguish the aphids from the leaf and count them automatically. *Credit: USDA-ARS, Midwest Area Soil and Water Management Unit, St. Paul, MN.*

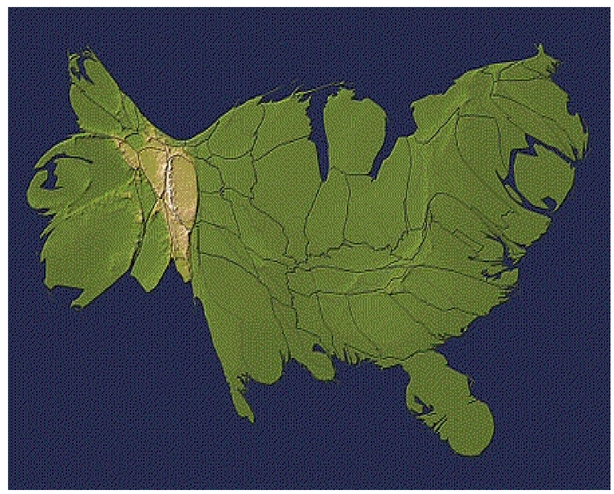
This seemingly low-tech problem turns out to pose a formidable technical challenge, with a potentially large economic impact. Soybeans are a key livestock feed in the United States, as well as being an important human food source in many parts of the world. In the form of biodiesel fuel, moreover, they are a promising source of renewable energy. To maximize yields, however, farmers currently have to plan their crop-dusting schedules based on slow manual counts of the aphids on sample soybean leaves.

Automating this process is a challenge because aphids are very good at hiding. They not only cluster near the veins of the leaf, which have an intricate structure, but they change their colors to blend in as the leaf ages. On young leaves, in fact, the aphids nearly match the leaf veins.

Nonetheless, the mathematician and his student were able to take a previously developed image-analysis algorithm and optimize it for soybean leaf images. Their method is completely automated, and requires no guidance from end users. Within a few weeks of taking up the challenge, the researchers were able to provide highly accurate, efficient aphid counts. (DMS).

► **Diffusion-based Method for Producing Density-equalizing Maps:** Map makers have long searched for a good way to construct cartograms: maps in which the sizes of geographic regions such as countries or provinces appear in proportion to their population or some other analogous property. Such maps are invaluable for representing census results, disease incidence, and other kinds of human data.

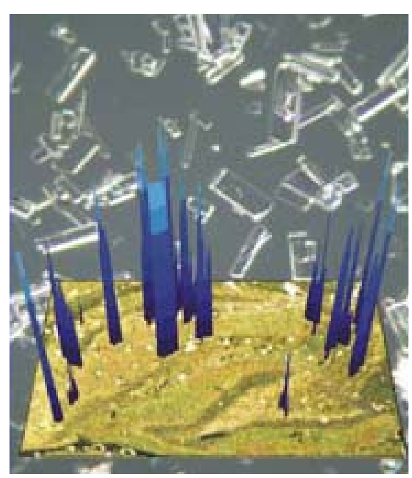
The challenge is to scale the regions and still have them fit together. This typically means distorting the regions' shapes, which often results in maps that are difficult to read. Many methods for making cartograms have been proposed, some of them extremely complex, but all suffer either from this lack of readability, or from other pathologies such as overlapping regions.



The population of the United States shown as a cartogram. *Credit: M. Gastner and M. Newman, Proc. Natl. Acad. Sci. USA 101, 7499-7504 (2004), Copyright 2004 National Academy of Sciences, U.S.A.*

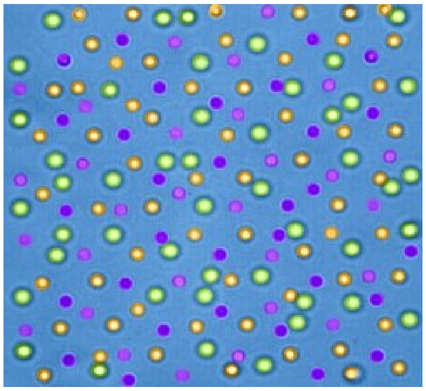
Now, however, NSF-funded mathematicians have developed a technique, based on ideas borrowed from elementary physics, that suffers none of these drawbacks. The method is conceptually simple and produces useful, elegant, and easily readable maps. (DMS).

► **Illuminating Alzheimer's. Research Sheds First-Ever Light on Creatine's Presence in Alzheimer's-Affected Brain Tissues:** For the first time, researchers have found elevated levels of creatine, a newly discovered agent of Alzheimer's, in brain tissue. Indeed, the team of Canadian and American scientists is the first to detect creatine directly in any tissue. Instead of following the usual method – grinding up a large amount of tissue and extracting creatine in bulk – the researchers were able to make a direct detection by using the intense light generated by the University of Wisconsin's Synchrotron Radiation Center, a traditionally physics-centric research tool. (DMR).



The image shows a hippocampus with the location of the creatine microcrystals shown by the blue peaks. The intensity of a blue peak corresponds to the intensity of the Infrared signal. *Credit: Kathleen Gough, University of Manitoba.*

► **Weaving and Bedazzling on a Microscopic Scale with "*Holographic Hands*"** Want to do handicrafts with beads smaller than the wavelength of light? Now you can, using a "holographic trapping" technique to capture microscopic beads floating in a liquid medium and to move and arrange them in patterns of your choice. The technique, perfected by Professor David Grier and his research group at the New York University, makes use of beams of laser light focused in ring-like patterns. These rings of light capture small particles floating in water. The rings can be used like tweezers to manipulate the particles and form the desired three-dimensional patterns. It is the next best thing to having full use of your hands at a microscopic scale. One can arrange micro-beads in three dimensions to construct crystals that mimic what atoms do at much smaller length scales, and to study them. The technique provides researchers a way to fabricate and study wires and structures of polymers, colloidal particles, carbon nanotubes, and membranes. Applications of this *holographic trapping* technique range from surgery within living cells to rapidly sorting fluid-borne objects. This award-winning technology has been commercialized and is being adopted for a wide range of industrial applications, including manufacturing of (photonic) devices that manipulate light much like semiconductors manipulate electrons in electronic circuits. (DMR).



A 'quasicrystal' with 5-fold symmetry assembled from nearly 200 colloidal spheres, a prototype for novel photonic (optical) devices. The spheres are colored by depth, and the five-fold domains should pop out of the picture if you stare at it. *Credit: David Grier, New York University.*

► **Using "Squishy Materials" to Teach Physics:** Is peanut butter a liquid or a solid? At times it seems like a solid: a glob of peanut butter will hold its shape over a period of time. Over time, however, it will flow like a liquid. Materials that behave in this manner are called complex fluids. Some of them change from solid-like to liquid-like, and vice versa, in response to changes in pressure. Many household items are examples, such as creams, shampoo, toothpaste, and ketchup. At Emory University, researchers study the physics of complex fluids to better understand their behavior. The group is interested in how a material's microscopic structure relates to its macroscopic behavior, such as determining how easy is it for a material to spread, flow, or compress – especially in confined spaces.

Postdoctoral fellow Dr. Denis Semwogerere shows a microscopic view of a squishy material. *Credit: Dr. Eric Weeks, Emory University.*

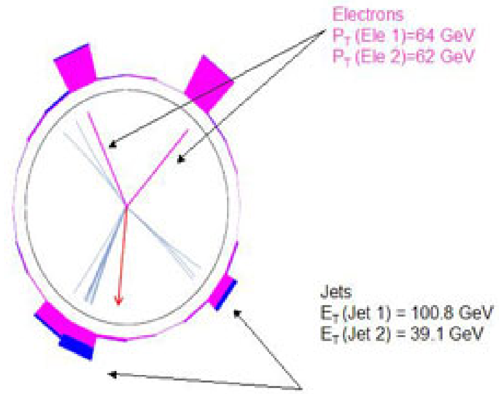
The Emory researchers have used activities involving "squishy materials" to interest schoolchildren in science. The laboratory has hosted groups from kindergarten through 8th grade, and children have the opportunity to study properties of these materials through age-appropriate hands-on activities. The excitement of doing physics research is conveyed to the children during these visits. The laboratory also has a popular website that contains extensive information on using complex fluids to teach freshman students (no matter which major they are pursuing) about current physics research while providing researchers particle tracking software and associated tutorials. (DMR).

Marisol Salgado of Roosevelt High School in Los Angeles works on microfluidic techniques for biological assays in the CSULA-CalTech Partnership for Research and Education in Materials. *Credit: CSULA. Prof. Frank Gomez.*

► **Partnerships Led by Minority-Serving Institutions:** Partnerships for Research and Education in Materials (PREM) enhance diversity in materials research and education by stimulating the development of long-term, collaborative research and education partnerships between minority-serving colleges and universities and NSF-supported centers and facilities in materials and condensed-matter research. PREMs engage the efforts and abilities of individuals from underrepresented groups in science and engineering who can have a significant impact on this critically important interdisciplinary field. Ten NSF PREM awards have been made to date; they constitute a developing national network of innovative partnerships with potential for major impact on materials research and education in the U.S. (DMR).

► **Open Science Grid Aids Search for Elementary Particles:** Theories in elementary particle physics explain a lot, but they all only make sense if fundamental particles have no mass, which is definitely not the case. So in order to account for the masses of particles, theorists add a special contribution to their equations. If this fix-up is correct, then a special, extremely heavy particle called a Higgs boson (after Peter Higgs, who suggested it) must exist. To find it, physicists have built larger and larger accelerators to go to higher and higher energy to produce this particle in collisions.

But measurements do not just require machinery and ingenuity; today it also helps to have the computing power of the grid. Why? The bulk of what is seen in a particle detector is unwanted signal, either from background or from other known signals. So, in order to see anything, theoretical physicists predict how the Higgs particle might be created and how it might decay, and experimental physicists model what those events would look like when viewed through a detector. Data collected from the detector is then compared with simulated data to see if any real events match what theory predicts a Higgs boson would cause, as well as to separate out the unwanted signals.



Simulation of Elementary Particle Collision. *Credit: Ashutosh Kotwal, Duke University.*

For two years, the Collider Detector at Fermilab (CDF) has been using a network of computers worldwide to simulate the hundreds of millions of events per year that are required to make discoveries and measurements. And for the last six months, they have been using the grid to help simplify job submission and management. The grid is ideal for simulations because there is not a lot of data transfer. What is needed is a lot of CPU. Through the Open Science Grid, simulations are being run on three CDF sites in North America, with three more to be added within the next few months. CDF simulations on the grid will also be extended to European sites. The grid will also be used for simulations on the detectors from the Large Hadron Collider when it begins operations. (PHY).

► **International Physics Young Ambassador Symposium:** More than 100 "physics young ambassadors" between the ages of 10 and 16, from 21 countries on five continents, winners of the International Physics Talent Search, met in Taipei, Taiwan to share the physics experience. The International Physics Talent Search was part of the World Year of Physics 2005 (WYP2005), proclaimed to celebrate the centennial year of three of Einstein's major discoveries. Held over New Year's Day 2006, the Symposium was the final event of WYP2005. The Talent Search implemented its goal of promoting physics awareness by allowing girls and boys to earn points through physics – drawing posters to illustrate the laws of physics, discovering that household items can demonstrate physical principles, teaching classmates about physics, or performing laboratory experiments. At the Symposium, the young ambassadors listened to and met with distinguished physicists, presented posters and talks on their work, and exchanged experiences with participants from other countries.

The impact of the event on the participants was beyond measure, as attested to by the comments from parents who participated in the Symposium. Travel to Taipei for U.S. participants and for those from several undeveloped countries was supported by the Office of Multidisciplinary Activities and the Divisions of Physics and Materials Research in MPS (which also supported the US Physics Talent Search) and by the Office of International Science and Engineering. (OMA, PHY, DMR; OISE).

U.S. symposium participants. *Credit: Beverly Hartline.*

Other Performance Indicators

Number of People Involved in MPS Activities

	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Senior Researchers	7,318	7,000	7,500
Other Professionals	2,373	2,400	2,450
Postdoctorates	2,214	2,250	2,300
Graduate Students	7,367	7,500	7,800
Undergraduate Students	6,242	6,300	6,500
K-12 Students	250	320	350
K-12 Teachers	480	500	550
Total Number of People	26,244	26,270	27,450

MPS Funding Profile

	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Statistics for Competitive Awards:			
Number	2,227	2,250	2,300
Funding Rate	30%	30%	30%
Statistics for Research Grants:			
Number of Research Grants	1,735	1,750	1,800
Funding Rate	28%	28%	29%
Median Annualized Award Size	$100,000	$103,000	$107,000
Average Annualized Award Size	$119,634	$132,000	$145,000
Average Award Duration, in years	3.1	3.1	3.1

ASTRONOMICAL SCIENCES $232,970,000

The FY 2008 Request for the Astronomical Sciences Division (AST) is $232.97 million, an increase of $17.86 million, or 8.3 percent, over the FY 2007 Request of $215.11 million.

Astronomical Sciences Funding

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Astronomical Sciences	**$199.75**	**$215.11**	**$232.97**	**17.86**	**8.3%**
Major Components:					
Research and Education Grants	79.46	89.86	102.78	12.92	14.4%
Centers Programs	4.00	4.00	3.32	-0.68	-17.0%
Facilities	116.29	121.25	126.87	5.62	4.6%
Gemini Observatory	18.18	20.00	20.50	0.50	2.5%
National Astronomy and Ionosphere Center (NAIC)	10.46	10.46	10.45	-0.01	-0.1%
National Optical Astronomy Observatory (NOAO) [1]	36.91	40.05	43.18	3.13	7.8%
National Radio Astronomy Observatory (NRAO)	50.74	50.74	52.74	2.00	3.9%

Totals may not add due to rounding.

[1] Includes the National Solar Observatory and the Telescope System Instrumentation Program.

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. Individual investigator awards, special grants, and fellowship programs for young faculty, postdoctoral researchers, graduate students, and undergraduate students encourage 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 supports the development of advanced technologies and instrumentation, planning and design for future observational facilities and collaborative projects in astronomy, and management of the electromagnetic spectrum for scientific use. In its quest to bring ever more powerful technology and a well-trained workforce to bear on the exploration of the universe, AST makes significant contributions to ACI.

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

- AST research and education grants range 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.

Approximately 20 percent of the AST portfolio will be available for new research grants in FY 2008. The remainder of the funds will support continuing commitments on research grants from prior years, facilities (55 percent of the total), instrumentation, education and outreach, and centers. In FY 2006, AST received 663 research proposals and made 158 competitive awards for a success rate of 24 percent.

AST Priorities for FY 2008:

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 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 2008, there will be renewed investments in the **Telescope System Instrumentation Program** (TSIP) and **Giant Segmented Mirror Telescope** (GSMT) technology development.

Gemini Observatory and ALMA operations and instrumentation are AST's highest priority in facility stewardship. Ensuring optimum performance and future instrumentation of our premier and newest facilities enables forefront research by the scientific community and their students in these international partnerships.

Changes from FY 2007:

Research and education grants increase by $12.92 million to $102.78 million total. AST will continue to support a wide range of astrophysical investigations from the search for extra-solar 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 be maintained at $5.0 million.

Funding for the **Science and Technology Center for Adaptive Optics** is $3.32 million, beginning the scheduled decrease as this STC sunsets.

Facilities increase by $5.62 million to $126.87 million total. Base operations funding for all facilities remains near the FY 2007 level, pending a full implementation plan for the recommendations of the Senior Review of AST facilities. See the Facilities chapter for details. Changes include:

- The increase of $500,000 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**. TSIP, administered through NOAO, increases by $1.0 million to $5.0 million.
- **NRAO** is supported at the level of $52.74 million, an increase of $2.0 million over the FY 2007 Request. The total includes $8.2 million for ALMA early operations.

CHEMISTRY $210,540,000

The FY 2008 Request for the Chemistry Division (CHE) is $210.54 million, an increase of $19.44 million, or 10.2 percent, over the FY 2007 Request of $191.10 million.

Chemistry Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Materials Research	**$180.78**	**$191.10**	**$210.54**	**$19.44**	**10.2%**
Major Components:					
Research and Education Grants	157.60	167.39	180.27	12.88	7.7%
Centers Programs	8.08	9.60	14.92	5.32	55.4%
Instrumentation/Facilities	15.10	14.11	15.35	1.24	8.8%

Totals may not add due to rounding.

About CHE:

Extraordinary research opportunities exist today in molecular science that build on our increasing understanding of matter, from its quantum properties to the formation of complex molecular assemblies. Chemistry is inherently interdisciplinary; important practical challenges provide the motivation for considerable academic creativity. The chemical enterprise that results from basic research investments is a major contributor to the U.S. economy.

Approximately 45 percent of the funding requested will be available for competitive research grants in FY 2008, with the remainder supporting continuing commitments on research grants from prior years and the other aspects of the portfolio. The CHE portfolio in FY 2006 consists of 79 percent individual and small group awards, 13 percent shared instrumentation, 4 percent educational projects, and 4 percent centers. The funding rate for proposals in CHE was 26 percent in FY 2006.

CHE priorities for FY 2008:

The Chemical Bonding Centers Program addresses major themes in the ACI such as sustainable technologies, nanotechnology, and molecular electronics. These centers foster interdisciplinary and transformational basic research with very high impact potential. The program philosophy encourages highly creative ideas at the cutting edge to develop new concepts that can lead to fundamental changes and new technologies.

Nanoscience, Complexity and Molecular Basis of Life Processes (MBLP): The co-evolution of nanoscience and personalized medicine and biotechnology requires synthesis of sophisticated molecular systems and understanding the interactions of molecules with these systems. To date studies have focused primarily on pairs of molecules; not much is known about more complex assemblies and the consequent phenomena resulting at larger scales. The goal is to program information at the molecular level through synthetic chemistry in order to induce self-assembly and cooperativity and eventually lead to the desired emergent properties. An ultimate goal would be to prepare carefully designed compounds and allow them to self-assemble into self-replicating systems. Self-assembly could lead to the formation of complex materials or devices with unique properties and provide clues to biological processes.

Science Beyond Moore's Law: An important and potentially transformative frontier in molecular science involves the design and synthesis of single-molecule electronic devices. Single-molecule transistors and diodes have already been synthesized and characterized and shown to act as regular devices. These systems work reproducibly and efficiently once they are constructed, but their assembly, connectivity and external addressability remain as major challenges. Other innovative structures need to be designed and synthetic and self-assembling schemes are necessary to produce more efficient and reproducible molecular devices. The potential to revolutionize the size and power of computers and other electronic devices based on molecular electronics is enormous, in perfect alignment with ACI goals.

Sustainability: Chemistry is an essential underpinning of major innovations in green technologies required for society to achieve a sustainable environment. This effort aligns with ACI, which calls for capabilities and technology platforms that will ensure innovation in key areas. There is global recognition that there is an urgent need to produce commodity chemicals not from petroleum but from carbon-neutral sources, such as biorenewable materials. Entirely new approaches need to be developed for the synthesis of chemicals and materials and for the utilization of energy and our natural resources. Study of the unique reactivity of environmental interfaces – for example between water and solids – is critical to understanding both natural biogeochemical cycles and those that have been altered by human activity. Scalable, cyber-enabled models can take molecular observations to regional and global outcomes. This mission is well-suited to NSF, with its emphasis on fundamental transformative research.

Cyber-enabled Discovery and Innovation: While computational modeling and simulation have always been part of chemical inquiry, the quality of science that has emerged from this approach has improved dramatically so that modeling, algorithms, software and simulation now are essential components to gain insights into chemistry. Particularly helpful are simulations of unrealizable systems such as ultrashort-lived key intermediate species that defy detection or of chemical species too dangerous to work with in the laboratory. Networking of remote instruments and facilities couples the people and instruments needed to synthesize and characterize new molecular systems.

Preparing the Workforce of the 21st Century: ACI calls for increased support for young investigators. CHE will increase support for CAREER and Discovery Corps Fellows, as well as continuing partnerships with EHR with the goal of preparing a diverse chemical workforce. CHE will participate in the MPS ACI Fellows pilot through activities requiring industrial collaboration, serving to increase research capacity in targeted ACI areas such as nanotechnology, cyber discovery, quantum science, energy security, and sensors. CHE funding for workforce activities increases by $3.80 million to $31.73 million in a mix of individual and group activities ranging from undergraduate students through junior professors.

Transformational Facilities and Infrastructure: The Chemical Research Instrumentation and Facilities (CRIF) program has four distinct tracks through which CHE addresses its priorities in Shared Instrumentation, Instrumentation Development, Facilities and Cyberinfrastructure. The broad range of chemistry's computational techniques and data types and its large number of independent data producers pose unique challenges. A concerted effort to develop the next generation of chemical imaging tools will have a significant impact on our ability to understand complex biological processes, chemical processes at catalytic surfaces and environmental processes, as well as sensors for national security.

Changes from FY 2007:

- Chemistry Centers increase by $6.0 million to $9.0 million total, reflecting establishment of one additional Phase II CBCs and three new Phase I centers. The STC will phase down by $0.68 million.
- Research and education grants increase by $12.88 million to $180.27 million total. Funding for Cyber-enabled Discovery and Innovation will increase by $1.2 million. CHE will support molecular electronics and Science Beyond Moore's Law with an investment of $3.0 million.
- Instrumentation/Facilities increase by $1.24 million to $15.35 million total, including new investments in cyber-enabled chemistry, multi-user facilities and instrument development.

MATERIALS RESEARCH $282,590,000

The FY 2008 Request for the Materials Research Division (DMR) is $282.59 million, an increase of $25.14 million, or 9.8 percent, over the FY 2007 Request of $257.45 million.

Materials Research Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Materials Research	**$242.59**	**$257.45**	**$282.59**	**$25.14**	**9.8%**
Major Components:					
Research and Education Grants	138.48	146.13	162.77	16.64	11.4%
Centers Programs	65.03	71.30	74.80	3.50	4.9%
Facilities	39.08	40.02	45.02	5.00	12.5%
National High Magnetic Field Laboratory (NHMFL)	24.25	25.00	27.50	2.50	10.0%
National Nanofabrication Infrastructure Network (NNIN)	2.52	2.55	2.55	-	-
Other MPS Facilities	12.31	12.47	14.97	2.50	20.0%

Totals may not add due to rounding.

About DMR:

The Division of Materials Research advances the intellectual frontiers of materials research. The activities supported are a critical component of the ACI. DMR awards enable the science and engineering 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 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 experimental and theoretical research over a broad range of subfields, including condensed matter and materials physics; solid state chemistry; polymers; biomaterials; ceramics; metals; and electronic, magnetic and photonic materials. 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. Ten awards for Partnerships for Research and Education in Materials (PREM) are aimed at broadening participation in the materials research field.

- DMR Centers address major interdisciplinary problems in materials and condensed-matter science. DMR plans to support up to 29 Materials Research Science and Engineering Centers (MRSECs) in FY 2008; three MRSECs are being phased out in FY 2007. The division also supports three Nanoscale

Science and Engineering Centers (NSECs), provides partial support for a further seven NSECs, and supports two Science and Technology Centers (STCs).

- 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 range of disciplines including materials and condensed-matter science, physics, chemistry, biology, geosciences, and many areas of engineering.

Approximately 20 percent of the funds requested for DMR in FY 2008 will be available for new competitive research grants; in addition about 10 percent of the funds will be available for the FY 2008 MRSEC competition. The remaining funds will support continuing commitments from prior years, facilities, instrumentation, and education and outreach. In FY 2006, DMR received 1466 research proposals and made 297 research grants for a success rate of 20 percent for research grants.

DMR Priorities for FY 2008:

Support for materials research programs that explore new phenomena, develop novel materials, and undergird technological innovation. These programs include awards to individual investigators, interdisciplinary teams, and centers. Emphasis will be given to research on materials and phenomena at the nanoscale; on complex systems including biomaterials; on computational discovery and innovation; and on the regime in materials and condensed matter where the quantum nature of matter increasingly comes into play. Such programs have significant potential for economic impact and for enhancing U.S. competitiveness.

Broadening participation in materials research. DMR will provide strong support for the participation of undergraduates, pre-college students and pre-college teachers in research, and for partnerships that strengthen the links between institutions serving under-represented 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 details about the National High Magnetic Field Lab, please see the Facilities Chapter.)

Changes from FY 2007:

DMR will increase support for **research and education grants** by $16.64 million to a total of $162.77 million. This will enhance support for research on nanoscale materials and phenomena; on complex systems including biomaterials; on materials aspects of computational discovery and innovation; and for fundamental research addressing “Science Beyond Moore’s Law”, encompassing novel materials and phenomena required for the future development of new computational and communications technologies.

DMR will increase support for the **centers programs** by $3.50 million to a total of $74.80 million. The increase will partially support two to three new materials centers to be established through open competition; further funds will be derived by phasing out support for re-competing centers as needed.

DMR will increase support for **facilities** by $5.0 million to a total of $44.02 million. This will enable continued operational support for X-ray, neutron and nanofabrication user facilities, and includes enhanced support for the conceptual design of future X-ray facilities and for operation of the National High Magnetic Field Laboratory.

MATHEMATICAL SCIENCES $223,470,000

The FY 2008 Request for the Mathematical Sciences Division (DMS) is $223.47 million, an increase of $17.73 million or 8.6 percent above the FY 2007 Request of $205.74 million.

Mathematical Sciences Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Mathematical Sciences	**$199.52**	**$205.74**	**$223.47**	**$17.73**	**8.6%**
Major Components:					
Research and Education Grants	199.52	205.74	223.47	17.73	8.6%

Totals may not add due to rounding.

About DMS:

The Mathematical Sciences Division advances the intellectual frontiers of the mathematical sciences and enables the advance of knowledge in other scientific and engineering fields. It plays a key role in training the nation's science and engineering workforce. Driven in part by increasingly sophisticated and readily available computing environments, advances in science and engineering require ever more sophisticated mathematical and statistical tools.

NSF plays a crucial role in support of basic academic research in the mathematical sciences, as it provides almost 80 percent of all federal university-based support. In the core mathematical areas this percentage is even higher, with NSF supporting a broader range of infrastructure and fundamental and multidisciplinary research topics than other federal agencies. DMS plays a dominant role in developing the next generation of mathematical scientists.

DMS supports areas such as analysis, geometry, topology, foundations, algebra, number theory, combinatorics, applied mathematics, statistics, probability, mathematical biology, and computational mathematics. Awards in these areas fund a variety of research projects, as well as 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. These include:

- DMS research grants range in scope from individual-investigator awards to awards for multidisciplinary groups of researchers to attack problems of mathematical and 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 to address the growing interface with other disciplines.

In FY 2008, approximately 60 percent of the funds requested for DMS will be available for new research awards, with the remainder going to continuing commitments from earlier years. In FY 2006, DMS received 2,272 research proposals and made 685 awards, for a success rate of 30 percent.

DMS Priorities for FY 2008:

Fundamental mathematical and statistical science includes activities that strengthen the core of the disciplines and enable effective partnering with other science and engineering disciplines. Single investigator and small group research grants form the core of the DMS portfolio and play a central role in advancing the frontiers of knowledge. This is a central enabler of the ACI.

Cyber-enabled Discovery and Innovation (CDI) in the mathematical sciences incorporates modeling, algorithms, and simulation to provide new ways of obtaining insight into the nature of complex phenomena in science and engineering. Emphasis areas essential to advancing the ACI include algorithm development and computational tools for large-scale problems of scientific importance, modeling of phenomena that occur over a large range of spatial and temporal scales, and finding patterns in the structure of large data sets.

Science Beyond Moore's Law (SBML) challenges the mathematical sciences to continue the algorithmic "Moore's Law" – i.e., the exponential increase in speed of basic computations due to innovative new algorithms, in parallel with Moore's Law for hardware – and to develop new mathematical frameworks for computation. Emphasis areas include algorithm design, analysis, and implementation; scalability in space and time; quantification of errors and uncertainty; and visualization of large data sets. This is a key component of the ACI.

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

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. Support for EMSW21 remain level.

Changes from FY 2007:

- **Support for the core** increases by $7.30 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. In addition, DMS will move to restore the recent gains made in supporting more graduate students and postdoctoral researchers within single investigator grants. Some of the investments in formal interdisciplinary partnerships through the now concluded Mathematical Sciences Priority Area will be continued. The remainder of these investments will be redirected to unsolicited proposals, while retaining their spirit and integrating them fully into the core.
- **Cyber-enabled Discovery and Innovation (CDI)** will be supported at the level of $5.20 million.
- **Science Beyond Moore's Law (SBML)** will be supported at the level of $1.50 million.
- **Discovery-based undergraduate experiences** will increase by $1.0 million and will build on current investments both within the mathematical sciences and on the interface with other disciplines. This activity is designed, in part, to better prepare students to pursue careers in fields that require integrated strengths between the mathematical sciences and other disciplines.
- **Mathematical sciences institutes and networks** will increase by $2.73 million to support the DMS portfolio of collaborations; research and training projects; scientific and public outreach activities; and programs to broaden participation in the mathematical sciences.

PHYSICS $ 269,060,000

The FY 2008 Request for the Physics Division (PHY) is $269.06 million, an increase of $20.56 million, or 8.3 percent, over the FY 2007 Request of $248.50 million.

Physics Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Physics	**$234.15**	**$248.50**	**$269.06**	**20.56**	**8.3%**
Major Components:					
Research and Education Grants	145.58	165.19	187.15	21.96	13.3%
Facilities	77.00	83.31	81.91	-1.40	-1.7%
Laser Interferometer Gravitational Wave Observatory (LIGO)	31.68	33.00	28.20	-4.80	-14.5%
Large Hadron Collider (LHC)	13.36	18.00	18.00	-	-
IceCube	-	-	1.50	1.50	N/A
National Superconducting Cyclotron Laboratory (NSCL)	17.34	17.60	19.50	1.90	10.8%
Cornell Electron Storage Ring (CESR)	14.62	14.71	14.71	-	-

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 cyber-enabled discovery and cyberinfrastructure; accelerator physics; and complex systems. 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.

In FY 2008, approximately 20 percent of the funds requested will be available for new research grants, with the remainder going to continuing commitments from previous years and to facilities (approximately

30 percent of the portfolio), instrumentation, and education and outreach. In FY 2006, PHY made a total of 277 competitive research grants, for a funding rate of 44 percent for competitive actions.

PHY Priorities for FY 2008:

- **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 cyber-enabled discovery, nanoscience, and biological physics. Additional large-scale, multidisciplinary research activities will be added through an open competition.

- **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 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 2007:

- Research and education grants increase by $21.96 million to a total of $187.15 million. PHY will continue to increase its 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, and expanding diversity within the research community, will receive continued emphasis.

- Facilities decrease by $1.40 million to a total of $81.91 million. For detail, see the Facilities chapter. This includes:

  - Decreased support for operations of the Laser Interferometer Gravitational Wave Observatory (LIGO) and for advanced detector R&D during startup of AdvLIGO construction to a total of $28.2 million, a decrease of $4.8 million.
  - Increased support for operations of Michigan State University's National Superconducting Cyclotron Laboratory radioactive ion beam facility at a total of $19.5 million, an increase of $1.9 million.
  - Initiation of operations for IceCube ($1.5 million)

MULTIDISCIPLINARY ACTIVITIES $34,370,000

The FY 2008 Request for the Office of Multidisciplinary Activities (OMA) is $34.37 million, an increase of $1.97 million, or 6.1 percent, over the FY 2007 Request of $32.40 million.

Multidisciplinary Activities Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Multidisciplinary Activities	**$29.90**	**$32.40**	**$34.37**	**1.97**	**6.1%**
Major Component:					
Research and Education Grants	29.90	32.40	34.37	1.97	6.1%

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. Approximately 80 percent of the funds requested will be available for new research and education grants. Almost all awards are managed in the MPS divisions with co-funding from OMA.

OMA Priorities for FY 2008:

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; in the multidisciplinary arena wherein the fundamental science beyond Moore's Law will be explored; 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 Science, Technology, Engineering, and Mathematics (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 2007:

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 $750,000 to the level of $5.0 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 FY 2007 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 2007 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 **NSF Graduate Teaching Fellows in K-12 Education** program (GK-12) will be maintained at the FY 2007 level of $3.0 million.

Investment in cooperative **international research and training activities** will be increased by $200,000 to the level of $1.4 million to enhance the global competitiveness of U.S. scientists, engineers, and students. This international portfolio includes 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** and are strongly aligned with the goals of the **ACI.** OMA places particular emphasis on fundamental investigations by multidisciplinary teams of scientists and engineers exploring science beyond Moore's Law, to be co-supported at the level of $2.0 million; on cooperative, high-risk research at the AST-PHY interface focused on Physics of the Universe, which will 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 $3.0 million.

SOCIAL, BEHAVIORAL AND ECONOMIC SCIENCES $222,000,000

The FY 2008 Budget Request for the Directorate for Social, Behavioral and Economic Sciences (SBE) is $222.0 million, an increase of $8.24 million, or 3.9 percent, over the FY 2007 Request of $213.76 million.

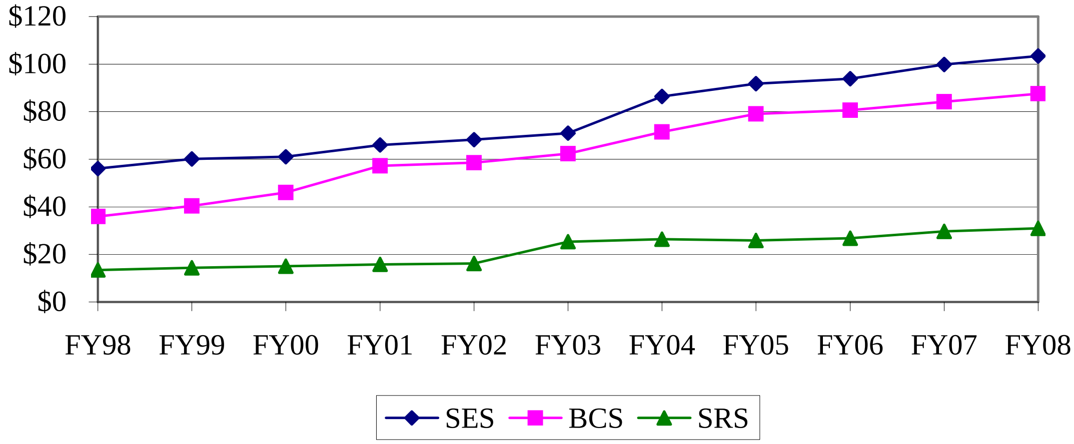
Social, Behavioral and Economic Sciences Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Social and Economic Sciences	$93.84	$99.92	$103.37	$3.45	3.5%
Behavioral and Cognitive Sciences	80.60	84.13	87.63	3.50	4.2%
Science Resources Statistics	26.79	29.71	31.00	1.29	4.3%
Total, SBE	$201.23	$213.76	$222.00	$8.24	3.9%

Totals may not add due to rounding.

The Directorate for Social, Behavioral and Economic Sciences supports research, infrastructure, and education primarily through grants to universities and other institutions. The research supported over the past decades has resulted in substantial advances in our understanding of human and social development; of perception, memory, linguistic, and reasoning processes; 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.

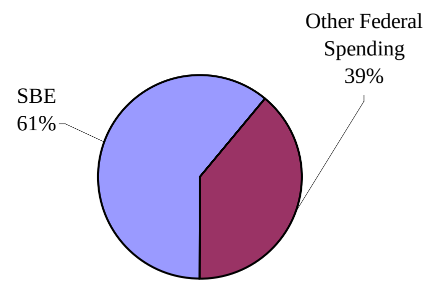
SBE Subactivity Funding
(Dollars in Millions)



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 61 percent of federal support for basic research in anthropology, social psychology, and the social sciences at U.S. academic institutions. In some fields, including archaeology, political science, linguistics, and non-medical aspects of anthropology, psychology, and sociology, SBE is the predominant or exclusive source of federal basic research support.

Federal Support for Basic Research in Anthropology, Social Psychology, and the Social Sciences at U.S. Academic Institutions



The SBE Directorate supports research and education efforts related to broad Foundation-wide investments through its ongoing funding of work in such areas as humans in the polar regions, science and innovation policy, homeland security, disaster recovery, education and learning, the health of the economy, networking and information technology, ecology, climate change, biotechnology, and nanotechnology. 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 scene recognition, responding to stressors, and interpreting truth versus deception; documenting endangered languages; the influence of fear on perceptions and decision making; network modeling; and the effects of terrorist assaults and natural disasters on people who are directly affected as well as those removed from physical harm but emotionally engaged with the victims. 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.

The American Competitiveness Initiative (ACI) calls for a better understanding of the economic and institutional mechanisms that enable our Nation’s workforce to generate and harness scientific and technological developments. SBE’s Science of Science and Innovation Policy (SciSIP) activities will develop an evidence-based platform from which policymakers and researchers may assess the impacts of the Nation’s science and engineering (S&E) enterprise, and improve their understanding of its dynamics and predict outcomes. Specifically, data collection, research, and community development components of SciSIP’s activities will: (1) improve and expand science metrics, datasets and analytical tools, yielding changes in the bi-annual S&E indicators and other data collections; (2) develop usable knowledge and theories of creative processes and their transformation into social and economic outcomes; and (3) build a community of experts in this area across the federal government, industry, and universities. SciSIP will support the development of new data, models, and tools, as well as facilitate transformative research on an immensely policy-relevant topic — the ecology of innovation. SBE is at the forefront internationally on the collection of data on the S&E workforce and research and development statistics. These data, in conjunction with the new theoretical models and analytical tools that will be developed with support from SciSIP, will inform and enhance the success of the ACI. 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 cyberinfrastructure-based data extraction techniques, and 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 S&E enterprise. SRS conducts, analyzes, and disseminates survey results relating to research and development (R&D) funding and facilities, the S&E workforce, and the education of scientists and engineers. SRS also gathers information on the international S&E enterprise and uses available information to describe the U.S. S&E role in a global economy. SRS activities, products, and services 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 S&E through its website (www.nsf.gov/statistics) and online databases.

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

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

Social and Economic Sciences (SES) +$3.45

Disciplinary and interdisciplinary research in SES increases by $3.45 million for the following research priorities: $1.35 million supports SciSIP research by contributing to the design of new metrics of sciences and related international collaborations; $1.0 million strengthens disciplinary and interdisciplinary research in the SES core that has transformative potential for disciplines within the social and economic sciences; and $1.10 million makes initial Cyber-enabled Discovery and Innovation (CDI) investments through programmatic support for interdisciplinary collaboratories and cybertools research that helps SciSIP.

Behavioral and Cognitive Sciences (BCS) +$3.50

Disciplinary and interdisciplinary research in BCS increases by $3.50 million for the following research priorities: $750,000 supports SciSIP's international research collaborations that promote understanding of discovery and innovation processes in individuals as well as teams; $1.25 million strengthens transformative and collaborative core disciplinary research; and $1.50 million supports research on behavioral and cognitive processes relating to physical systems, brains, and human intelligence.

Science Resources Statistics (SRS) +$1.29

SRS increases by $1.29 million for funding of enhancements to data collections on the S&E workforce, especially work related to postgraduates; beginning work on a module on innovation for industry; and design of new indicators and data on research and development by nonprofits. All of these are significant enhancements directly related to the ACI and SciSIP.

Subtotal, Changes +$8.24

FY 2008 Request, SBE...$222.00

Summary of Major Changes by Directorate-wide Investments	***(Dollars in Millions)***
SBE FY 2007 Request……………….…………………………………….…….........................	**$213.76**
<u>Discovery Research for Innovation</u>	+6.95

Disciplinary and interdisciplinary research
Increased funding will support the following areas:

- *Science of Science and Innovation Policy (+$2.10 million)*. $600,000 contributes to SciSIP investment by supporting fundamental research that leads to improved and expanded science metrics, datasets, and analytical tools from which researchers and policymakers may assess the impacts and improve their understanding of the dynamics of the Nation's S&E. The remaining $1.50 million supports international research collaborations that promote global and comparative understanding of the dynamics of science and technology. This investment in SciSIP is supplemented by a $700,000 investment in transformational infrastructure, which is discussed below. In all, SBE's total three-year commitment, which began in FY 2006, is $25.89 million.

- *Strengthening the Core (+$3.75 million)*. $2.25 million supports core programs, including potentially transformative research with implications for methods, methodologies, or theories that transcend fields, as well as cross-disciplinary collaborations that include psychological, economic, anthropological, sociological, geographic, and management sciences. An additional $1.50 million will support a special emphasis on research that links behavioral and cognitive processes to related advances in neuroscience. This research focuses on developing new collaborations, approaches, and tools to address issues such as complex pattern recognition, feedback and homeostatic mechanisms, social and motivational processes, action planning and coordination, learning and communication; information integration across multiple modalities; and adaptability and plasticity.

- *Cyber-enabled Discovery and Innovation (+1.10 million).* $1.10 million funds SciSIP's interdisciplinary collaboratories and data extraction research and is supplemented by a Transformational Facilities and Infrastructure investment of $590,000, discussed below, bringing the total investment in CDI to $1.69 million.

<u>Transformational Facilities and Infrastructure</u>	+$1.29

$1.29 million will allow SRS to redesign data collections to better reflect how science is conducted in the 21st century and to contribute to the design and development of new science and technology indicators. Of this additional amount of funding:

- $700,000 supports SciSIP (see discussion above); and

- $590,000 supports SciSIP through the investment in Cyber-enabled Discovery and Innovation, as mentioned above.

Subtotal, Changes	+$8.24
FY 2008 Request, SBE………………………………..………………………………………......	**$222.00**

NSF-WIDE INVESTMENTS

In FY 2008, the SBE Directorate will support research and education efforts related to broad, Foundation-wide investments in a number of areas, including NSF's multidisciplinary investment areas and the Administration's interagency R&D priorities.

SBE NSF-wide Investments
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Biocomplexity in the Environment	$0.15	$1.08	-	-$1.08	-100.0%
Climate Change Science Program	15.48	15.48	15.48	-	-
Cyber-enabled Discovery & Innovation	-	-	1.69	1.69	N/A
Cyberinfrastructure	20.54	20.54	20.54	-	-
Human and Social Dynamics	31.40	31.40	31.40	-	-
International Polar Year	2.40	5.00	2.00	-3.00	-60.0%
Mathematical Sciences	1.40	0.75	-	-0.75	-100.0%
National Nanotechnology Initiative	1.56	1.67	1.67	-	-
Networking and Information Technology R&D	12.47	12.47	14.47	2.00	16.0%

Biocomplexity in the Environment and **Mathematical Sciences:** With the conclusion of these priority areas in FY 2007, key components of these investments will be retained for core programs. Through collaborations with the Biological Sciences and Geosciences Directorates, SBE is providing core funding to continue support for cross-disciplinary research focused on Coupled Natural and Human Systems. This will continue to foster increased collaborations across the natural, social and behavioral sciences to address complex environmental issues and processes.

Climate Change Science Program (CCSP): Support for CCSP remains level with the FY 2007 Request at $15.48 million. SBE's CCSP investments are concentrated on "Human Contributions and Responses," focusing on how people (individually, in groups, or through organizations) interact with natural environmental systems, and how these interactions affect and are affected by environmental change.

Cyber-enabled Discovery and Innovation: SBE will provide $1.69 million in support of interdisciplinary collaboratories and data extraction research.

Cyberinfrastructure: Cyberinfrastructure support remains at $20.54 million, level with the FY 2007 Request. 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. Continued investments will prepare scientists and educators to use, design, develop, and support cyberinfrastructure with the needs of the SBE sciences in mind.

Human and Social Dynamics (HSD): Support for this SBE-managed priority area totals $31.40 million, unchanged from the FY 2007 Request. Almost every major challenge this country faces, ranging from climate change, to terrorism, to the need for an educated, diverse, and innovative 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 involving 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. HSD used the Small Grants for Exploratory Research mechanism to provide funding rapidly to interdisciplinary teams seeking to study social, behavioral and organizational aspects of the response to natural disasters such as Hurricane Katrina. The knowledge gained from this type of research will better inform our ability to anticipate and respond to future events.

International Polar Year (IPY): SBE will participate in IPY activities through collaboration with the Office of Polar Programs for a total of $2.0 million. Although SBE is reducing its participation by $3.0 million, it will continue to augment its IPY investments through related core activities. Through its "gold-standard" General Social Survey (GSS), SBE provided a survey vehicle for IPY specific questions in 2006 that addressed Americans' knowledge of the polar regions. SBE plans to continue this series of questions in future GSS cycles so as to provide longitudinal data on this topic. The FY 2008 resources will support interdisciplinary, and where appropriate, international research on human adaptation and change within polar environments that focus on human-environment interactions from a range of perspectives, including physical anthropology, cultural anthropology, cognitive neuroscience, sociology, geo-political relations, and economics, as well as science and technology studies. Human adaptations reflected in native languages and cultures will be documented. Social and economic aspects of nutrition, mental well-being, and infectious diseases will also be examined.

National Nanotechnology Initiative (NNI): This priority area support is maintained at $1.67 million. SBE's support for NNI enables research and educational activities that focus on issues of nanotechnology R&D and societal consequences, on both a domestic and global scale. This will enable continuing interdisciplinary participation in NSF-wide nanotechnology areas.

Networking and Information Technology R&D (NITRD): NITRD funding increases $2.0 million over the FY 2007 Request, for a total of $14.47 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 2006, the last year for which complete data exist, 95 percent of research funds were allocated to projects that underwent external merit review.

To ensure the highest quality of processing and recommending proposals for award, SBE convenes Committees of Visitors (COVs), composed of qualified external evaluators, to review each program every three years. These experts assess the integrity and efficiency of the proposal review process and provide a retrospective assessment of the results of NSF's 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

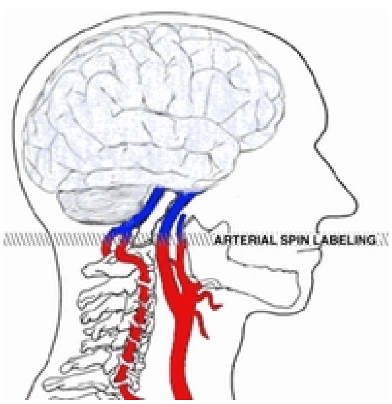
The FY 2008 Budget Request is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals stated in the FY 2006-2011 Strategic Plan. These goals provide an overarching framework for progress in fundamental research and education and facilitate budget and performance integration.

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

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Discovery	$156.04	$156.39	$163.34	$6.95	4.4%
Learning	8.88	9.27	9.27	-	-
Research Infrastructure	33.59	44.30	45.59	1.29	2.9%
Stewardship	2.72	3.80	3.80	-	-
Total, SBE	$201.23	$213.76	$222.00	$8.24	3.9%

Totals may not add due to rounding.

Recent Research Highlights



The continuous arterial spin labeling (CASL) method is very similar to positron emission tomography (PET) scanning but does not require injections or radioactivity. To measure blood flow in the brain, the technique uses a functional magnetic imaging (fMRI) magnet to "tag" water molecules in the patient's blood, which then serve as a natural contrast agent. *Credit: University of Pennsylvania School of Medicine.*

► **A New Method for Measuring Effects of Stress on the Brain:** John Detre and his colleagues at the University of Pennsylvania are developing and testing improved functional magnetic resonance imaging (fMRI) methods for visualizing human brain function. As in conventional fMRI studies, these methods estimate the amount of neural activity at any given point in the brain by measuring how fast the blood is flowing there – quantities that turn out to be closely linked. Unlike the conventional studies, which measure the blood flow by indirect means, Detre and his coworkers are measuring blood flow directly with a technique called continuous arterial spin labeling (CASL). In effect, they magnetically "tag" the water molecules in a person's blood on its way to his or her brain.

As a demonstration, the researchers used CASL on individuals subjected to mental stress in the form of a demanding mental arithmetic task. They detected an increase in blood flow in the right prefrontal cortex, which is where such tasks are carried out. Moreover, they found that the change continued even after the task was completed, suggesting that the effects of a transient mental stressor are more persistent than commonly thought. Improvements in perfusion MRI for measuring changes in brain function could yield superior sensitivity to conventional fMRI methods for measuring prolonged cognitive or emotional states such as those imposed by mental stress. (BCS).

► **"Thinking Like A Scientist" Helps Underrepresented Youth Use Science in the Real World:** High-school science courses traditionally focus on a subject's content – genes in biology, for example, or the periodic table in chemistry. Yet many studies have shown that students quickly lose interest in such courses. They find the material abstract, lifeless, and irrelevant. They quickly forget what they have learned. Even when they do not forget, they have a great deal of trouble transferring their knowledge to new problems, situations, or domains.

Now, however, Cornell University psychologist Wendy M. Williams has developed a program that explicitly teaches high-school students how to use the problem-solving methods of science to deal with situations they encounter in daily life. Williams' "Thinking Like A Scientist" program is designed to be taught by regular science teachers who assign tasks and quizzes that reinforce its themes. Their basic strategy is to talk about everyday topics, while simultaneously smuggling in principles of effective thinking using the scientific method.

Williams tested this approach on 400 students from high schools in North Dakota, Arizona, Alabama, Iowa, and New York, with additional trials in summer school and after-school venues in other states. The results showed success in virtually all groups. That success, in turn, suggests that underrepresented youth may have competencies in science that are not brought out by traditional science instruction. (BCS).

► **Including Public Attitudes in Wetland Restoration Priority Setting:** To assist managers in assessing the tradeoffs among different wetland restoration projects, an interdisciplinary team at the University of Rhode Island has developed a method to estimate the public benefits of each one. The team, which included both social scientists and natural scientists, worked in close collaboration with state officials. They first linked how the physical attributes of wetlands contribute to habitat functions for various species, and then identified public values associated with changes in salt marsh functions. Public values were assessed regarding habitat, mosquito control, recreational access, and cost.

Table 1. Species Groups in Restoration Assessment Methodology

Species Group:	Example Species:
Wading birds:	Egrets, herons
Waterfowl	Ducks, geese, swans
Shorebirds:	Killdeer, plovers, sandpipers
Marsh dependent songbirds:	Seaside sparrows, sharptail sparrows
Other songbirds:	Thrushes, warblers
Marsh resident fish:	Killifish, mummichogs, silversides, sticklebacks
Marsh non-resident fish:	Bluefish, menhaden, mullet, striped bass, flounder
Shellfish	Clams, crabs, mussels, oysters, scallops, snails

Credit: Table courtesy of James Opaluch.

Based on their results, the team created a web-based application (http://simlab.uri.edu/saltmarsh/) that can be used by decision makers and the public to assess and prioritize restoration actions. All sites are existing wetlands that were subject to various impacts, such as ditching, impoundment, disposal of dredge spoils, runoff from development, erosion, and sedimentation. (BCS).

► **Summer Economics Training Program Reaches Minority and Disadvantaged Students:** The American Economics Association's summer training program has been continuously successful in providing American minority students and students from disadvantaged backgrounds with coursework and research experience in preparation for graduate study in economics. Overall, the program is likely to increase the long-term supply of minority economists by at least 25 percent.

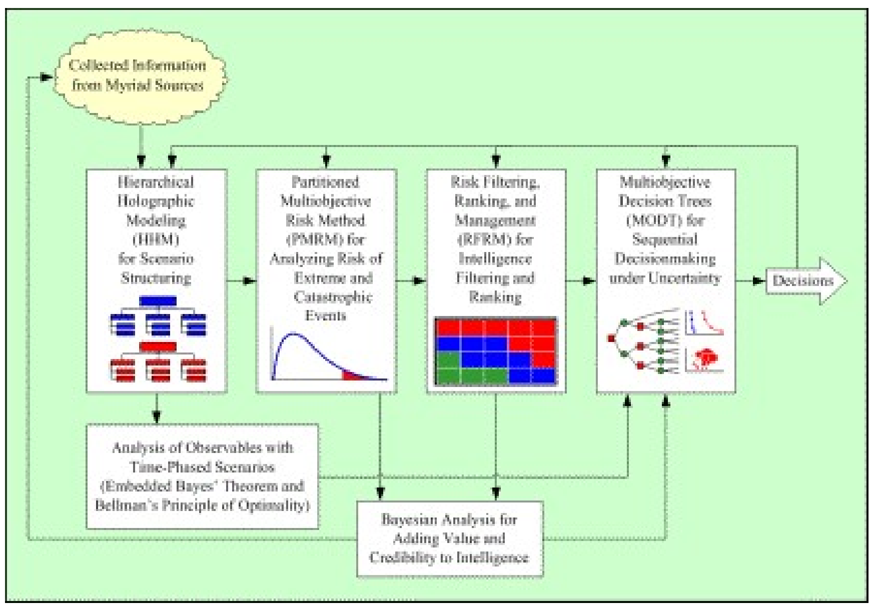
The program recruits overwhelmingly from non-research institutions with predominantly minority and low-income student bodies. The 2005 program had 39 students from 37 colleges or universities in 24 states. In the program's two years at Duke University, 44 percent of the participants were female, 55 percent were African American, and 31 percent were Hispanic.

AEA summer training program participants in the Federal Reserve boardroom. *Credit: Prof. Charles Becker, Director, AEA Summer Training Program.*

When students were surveyed at the end of the 2005 summer, about four in five of those who completed the program indicated they were either certain or very likely to enter a Ph.D. program in economics, compared to just over half of the students surveyed at the beginning of the summer. Of the 132 participants during the period 2001-2005, 57 students are expected to be enrolled in a Ph.D. program during the 2006-2007 academic year. (SES).

► **A Scenario-based Method for Identifying Terrorism Targets:** Yacov Haimes and his colleagues at the University of Virginia have developed a scenario-based "game" for identifying and prioritizing security vulnerabilities related to critical infrastructure. The game is built around an interactive, multidimensional analysis method called the hierarchical holographic method (HHM) developed by the same team.

The team has refined and extended this innovative risk-assessment methodology by working on real terrorism-assessment problems. By combining research and development with application studies, the risk assessment method is simultaneously tested, improved and used to help solve a pressing national problem.



The Methodological Framework: A process for scenario-based tracking used to identify and prioritize security vulnerabilities of critical infrastructure. *Credit: Yacov Haimes, University of Virginia.*

Working with the Virginia Department of Transportation, the researchers have used the game to identify security vulnerabilities around a gubernatorial inauguration. Additionally, working with the Department of Homeland Security, they have used it to aid decision analysis associated with the department's color alert system. They have also analyzed risks to U.S. Army critical infrastructure to help prioritize protection of critical army assets. (SES).

► **Improvements in NSF's Survey of Industrial Research and Development:** The National Science Foundation's Science Resources Statistics program is in the midst of a major redesign of its Industrial Research and Development Survey to better reflect how research and development (R&D) is conducted in the 21st century. The redesign was emphasized as a major priority in the NRC report, *Measuring Research and Development Expenditures in the U.S. Economy*.

The Survey is the primary source of information on R&D performed by industry in the United States and is widely used by government agencies, corporations, and research organizations. In its redesigned form, it will be a major analytical tool helping to inform policymakers in support of the ACI. One unique aspect of the redesign is an extensive series of interactions with survey respondents and data users. Over 40 recordkeeping visits to a broad range of companies have already been carried out, with many additional visits expected as the redesign continues. In addition, an Industry Experts Panel, composed of major industrial leaders, held three meetings to advise on the development of the survey and subsequent meetings will be held as the redesign progresses. Extensive data-user meetings and workshops have been held to ensure that the redesigned survey meets user needs. (SRS).

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 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Senior Researchers	3,033	3,100	3,150
Other Professionals	453	475	500
Postdoctorates	196	200	210
Graduate Students	1,661	1,650	1,675
Undergraduate Students	1,208	1,220	1,220
K-12 Teachers	10	10	10
Total Number of People	6,561	6,655	6,765

SBE Funding Profile

	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Statistics for Competitive Awards:			
Number	1,145	1,215	1,265
Funding Rate	25%	25%	25%
Statistics for Research Grants:			
Number of Research Grants	713	760	790
Funding Rate	22%	22%	22%
Median Annualized Award Size	$85,136	$86,000	$86,000
Average Annualized Award Size	$102,527	$103,000	$103,000
Average Award Duration, in years	2.4	2.4	2.4

SOCIAL AND ECONOMIC SCIENCES $103,370,000

The FY 2008 Budget Request for the Division of Social and Economics Sciences (SES) is $103.37 million, an increase of $3.45 million, or 3.5 percent, over the FY 2007 Request of $99.92 million.

Social and Economic Sciences Funding

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Social and Economic Sciences	**$93.84**	**$99.92**	**$103.37**	**$3.45**	**3.5%**
Major Components:					
Research and Education Projects	93.84	99.92	103.37	3.45	3.5%

Totals may not add due to rounding.

About SES:

The Division of Social and Economic Sciences supports research and related activities, conducted within the U.S. and globally, to improve systematic understanding of political, economic, and social institutions and how individuals and organizations behave 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 established 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 (sometimes only) source of federal funding for fundamental research, and SES is a principal investor in the data resources and methodological advances that produce transformative research.

In general, 52 percent of the SES portfolio is available for new research grants. The remaining 48 percent is used primarily to fund continuing grants made in previous years. SES supports research and education through grants that range in size from small supplements for undergraduates to collaborate with faculty on research projects to multi-million-dollar survey awards such as the *Panel Study of Income Dynamics*, the *American National Elections Studies*, and the *General Social Survey.* These are national resources for research and decision making that have become models for similar efforts in other societies.

SES is strengthening these surveys through investments in cyberinfrastructure that increase response rates, improve quality, and shorten the time required to design, field, and analyze questionnaire surveys. The Time-sharing Experiments for the Social Sciences (TESS) uses the internet as a medium for conducting survey-based experiments. Not only does TESS allow innovative research design, it also widens access to high-quality survey data and lowers the research costs for participating investigators.

SES contributes to Foundation-wide efforts to understand the ethical, legal, and social dimensions of science, engineering, and technology by coordinating the Ethics Education in S&E Program, by supporting (with other NSF directorates) the Online Ethics Center for Engineering and Science, and by taking a lead role in managing the Centers for Nanotechnology in Society. These collaborative activities contribute to the education of scientists and engineers and shape the trajectory of research and development.

SES Priorities for FY 2008:

- Assume a major role in the development of SciSIP to improve understanding of the research and innovation processes and to design better metrics of science. Investments will initiate fundamental research into the organization and dynamics of science and innovation, with special attention to their implications for science metrics. Funds will also be used to strengthen international collaborations among researchers concerned with science and innovation dynamics, metrics and policies.
- Strengthen core social science programs through targeted investments in potentially transformative research areas. Within these sciences, SES will increase support for research that uses or develops qualitative and quantitative methods and for research concerned with knowledge production and the process of innovation.
- Support research in Cyber-enabled Discovery and Innovation that will build a foundation for SciSIP. Computers and related technologies applied to new data resources provide analytic access to cognitive and social phenomena that had been invisible and unmeasured. New cybertools and institutional arrangements for organizing and analyzing such data will offer new insights into the processes of knowledge production and innovation.

Changes from FY 2007:

Support for the SES Division increases by $3.45 million:

- $1.35 million will support SciSIP research contributing to the design of new metrics of science ($600,000) and related international collaborations ($750,000). These investments will initiate fundamental research into the organization and dynamics of science and innovation, and will contribute to the development of new metrics of science. Funds will also be used to start and strengthen international research collaborations concerned with science and innovation.
- $1.0 million will strengthen fundamental research in core programs that has transformative potential for the social and economic sciences. SES will give particular emphasis to the development and use of new qualitative and quantitative methods and to studies of the production, dissemination, and use of knowledge.
- $1.10 million will make initial CDI investments through programmatic support for interdisciplinary collaboratories and cybertools that extract and organize data from large-scale qualitative databases. New computer and communications technologies, applied to newly-created data resources, will reveal patterns of behavior that had been invisible, unmeasured, and unexamined.

BEHAVIORAL AND COGNITIVE SCIENCES $87,630,000

The FY 2008 Budget Request for the Division of Behavioral and Cognitive Sciences (BCS) is $87.63 million, an increase of $3.50 million, or 4.2 percent, over the FY 2007 Request of $84.13 million.

Behavioral and Cognitive Sciences Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
Behavioral and Cognitive Sciences	**$80.60**	**$84.13**	**$87.63**	**$3.50**	**4.2%**
Major Components:					
Research and Education Projects	80.60	84.13	87.63	3.50	4.2%

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, thought processes, language, learning, and social behavior across neural, 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 as well as how these variations and related patterns develop over time. The division also supports efforts to increase basic understanding of and capabilities to explore geographic distributions and relationships, with an emphasis on interactions of human, physical, and environmental systems on the Earth's surface. Strong core programs are complemented by active involvement in competitions that support collaborative and cross-disciplinary projects to advance knowledge and build capacity by bridging multiple fields.

In general, 62 percent of the BCS portfolio is available for new research grants. The remaining 38 percent is used primarily to fund continuing grants made in previous years. The BCS portfolio mainly supports research and education grants ranging in scope from dissertation and individual-investigator awards to larger group projects that span multiple disciplines and institutions. Major activities include:

- Understanding fundamental human processes including language, cognition, perception, reasoning, and action planning, in relation to adult and childhood developmental processes;
- Providing fundamental understanding of human social behavior including attitude formation and change, social cognition, affective and motivational influences, and personality processes;
- Integrating qualitative and quantitative analyses to better understand cultures;
- Understanding human biological variation, human adaptation, and human ontology;
- Using a geographic framework for understanding social, political, and economic transformations;
- Facilitating research to address the complexity in human-environmental interactions;
- Using non-linear models to understand dynamics of human behavior on time scales from the momentary to the millennial; and
- Creating platforms for annotating and archiving textual, audio, and video language samples, as well as accessing the material for analyses.

Within BCS, there is a continuing emphasis on integrating findings from multiple perspectives to elucidate how human beings think, learn, and behave as individuals and as members of various socially and culturally-defined groups. Through support of basic research, the behavioral and cognitive sciences are advancing knowledge of the relations between brain and thought processes, between individual differences and cultural contexts, and between human and environmental systems. As examples, BCS research is helping us to prepare for and mitigate the effects of natural and manmade disasters, to predict and address how people respond to stressors, to improve methods for effective learning, to enhance the quality of social interaction, and to respond to issues such as globalization, terrorism, and climate change.

Ongoing initiatives within BCS include human and social dynamics, documenting endangered languages, understanding child learning, studying human origins, and understanding the interplay between humans and the environment. 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.

BCS Priorities for FY 2008:

- Participate in the development of SciSIP to increase understanding of the discovery and innovation processes, with special emphasis placed on cognitive, affective and motivational processes that enhance creativity and innovative thinking; improved measurements of psychological outcomes such as success, well-being, and satisfaction; and identification of group processes that facilitate idea generation, team coordination, and translation into successful applications. These efforts will bring together international collaborative teams to advance fundamental knowledge regarding how discoveries are encouraged, nourished and disseminated.
- Strengthen the basic research enterprise and encourage transformative research in the behavioral, cognitive, anthropological, and geographic sciences through enhancement of the support provided to core programs that serve these critical research communities. In particular, BCS will emphasize additional funding in areas that are expanding in new directions and increasing cross-disciplinary interactions such as social cognition and human-environment interactions.
- Advance understanding about the interplay among physical systems, brains, and human intelligence, with research focused on developing new collaborations, approaches, and imaging techniques to discover the brain mechanisms involved in the cognitive functions of language, perception, memory, emotion, etc.

Changes from FY 2007:

Support for the BCS Division increases by $3.50 million:

- $750,000 supports international research collaborations as part of the SciSIP activity to promote fundamental understanding of discovery and innovation processes in individuals and teams.
- $1.25 million strengthens core disciplinary research to enhance the number of transformative projects in areas that expand in new directions and increase cross-disciplinary interactions.
- $1.50 million supports research on cognitive and behavioral processes associated with physical systems, brains, and human intelligence, including research on language, learning, social processes, cognition, and higher-order perception.

SCIENCE RESOURCES STATISTICS $31,000,000

The FY 2008 Budget Request for the Division of Science Resources Statistics (SRS) is $31.0 million, an increase of $1.29 million, or 4.3 percent, over the FY 2007 Request of $29.71 million.

Science Resources Statistics Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Percent
Science Resources Statistics	**$26.79**	**$29.71**	**$31.00**	**$1.29**	**4.3%**

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, in its role as a federal statistical agency with responsibility to cover the S&E enterprise, 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 data collected by SRS serves as an important tool for ACI.

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 2008 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 2008, 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.
- Significantly improve the *Survey of Graduate Students and Postdoctorates in Science and Engineering* with further implementation of redesigned survey components after significant testing.
- Continue collection and dissemination of breakthrough data collections on cyberinfrastructure in academic and biomedical facilities. Data were first collected in FY 2004 and similar data with an updated questionnaire will go into the field in FY 2008, collecting data covering parts of 2006-2009.
- Maintain continuous improvement in the relevance and quality of all its products. In FY 2008, SRS will implement 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/improvements to major components of many SRS surveys and continuing to explore the feasibility of new information collection efforts begun in prior years to meet the needs of the ACI, SciSIP, and a broad range of data users.

- SRS is responsible for the major data components of SciSIP. In support of SciSIP and ACI, in FY 2006 and FY 2007 SRS held a series of workshops with Industry and S&E workforce experts, data users and innovation experts. These workshops have significantly enhanced the redesigns underway for the SRS surveys and additional workshops will be held in FY08.
- Enhance and expand existing on-line systems for user access to SRS data and the SRS database archive to support the SciSIP initiative. Continue efforts to enhance information on the globalization of the S&E enterprise, through continued interaction with OECD, EUROSTAT, the UNESCO Institute for Statistics and other international and national statistical agencies.
- Continue the redesign of the Academic Research and Development Survey so it reflects the major changes that have occurred and are taking place in the academic sector as to how research and development are funded and conducted.

SRS Priorities for FY 2008:

As the federal statistical agency responsible for data on the U.S. S&E enterprise, SRS will:

- Continue dissemination of data from 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* and plan the 2008 surveys, which will begin data collection in October 2008. Data from the three surveys comprise the Scientists and Engineers Statistical Data System (SESTAT), the primary source of statistical data on the S&E workforce.
- Develop plans, based on pilot activities in FY 2007, for data collection activities to gather information about individuals in postdoctorate positions, including individuals with foreign doctorates.
- Complete and release the *2008 Science and Engineering Indicators* report. Plan and develop the *2009 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.
- Continue 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. Final decisions on the format of the question will be made as well as analytical plans for the data. The question will provide ongoing data on the size and characteristics of the S&E workforce and important critical data on inflows of foreign science and engineers.
- Major progress will be made on redesigning the *Survey of Industrial Research and Development* (*SIRD*). Following extensive data user and supplier interactions, final decisions will be made on content and preliminary drafts of the questionnaire will be developed. Plans for procedures, methods and development of the pilot design will be underway.

Changes from FY 2007:

Funding increase of $1.29 million to a total of $31.0 million is for work connected with the SciSIP:

- Use $590,000 under the CDI Investment area to design a module on innovation to be used in conjunction with the Survey of Industrial Research and Development. SRS will draw upon input from practitioners in the field of innovation to develop a very small module to provide much needed innovation data.
- Use $700,000 for design and development of new indicators related to R&D funded and conducted by nonprofit institutions. A major component of SciSIP is to provide the data for an enhanced understanding of how research is conducted in the United States.

OFFICE OF CYBERINFRASTRUCTURE $200,000,000

The FY 2008 Budget Request for the Office of Cyberinfrastructure (OCI) is $200.0 million, an increase of $17.58 million, or 9.6 percent, over the FY 2007 Request of $182.42 million.

Office of Cyberinfrastructure Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Cyberinfrastructure	$127.14	$182.42	$200.00	$17.58	9.6%

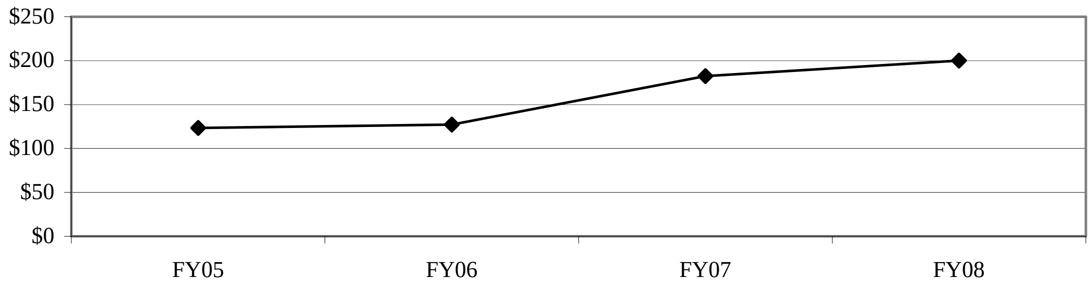
The Office of Cyberinfrastructure supports the development, acquisition, and operation of state-of-the-art cyberinfrastructure resources, providing cyberinfrastructure services that promote otherwise unrealizable advances in 21st century science and engineering research and education. OCI was created in July 2005 in an organizational realignment that moved the CISE Division of Shared Cyberinfrastructure (SCI) into the Office of the Director. At the same time, a Cyberinfrastructure Committee (CIC), composed of members of NSF's senior management, was created. The CIC provides integration and strategic vision across NSF's portfolio of cyberinfrastructure activities. In FY 2007, funds were added to the OCI budget to begin the acquisition of a leadership-class high-performance computing (HPC) system optimally configured to enable *petascale* performance (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)) on important science and engineering problems.

OCI-supported cyberinfrastructure includes information technology 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, an array of software tools and services that enhance the usability and accessibility of computational, observational and experimental infrastructure, and digital collaboratories. 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 advanced networking, high-end computing and cyberinfrastructure priorities, and are key components in the interagency Networking and Information Technology Research and Development (NITRD) priority. The technologies developed and the systems deployed by OCI facilitate discovery and innovation and bolster national competitiveness. The American Competitiveness Initiative (ACI) describes the goal of providing world-leading, high-end computing capability, coupled with advanced networking, to enable scientific advances through modeling and simulation at unprecedented scale and complexity across a broad range of scientific and engineering disciplines. OCI investments in high-performance computing for research and education, the TeraGrid infrastructure, and international network connections directly contribute to this goal.

OCI will participate in the new NSF-wide investment area of "Cyber-enabled Discovery and Innovation," enabling cyberinfrastructure in collaboration with several of NSF's directorates.

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, the dark matter particle or a black hole? Can we create an individualized model of each human being for personalized 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 and other questions are only now coming within our ability to answer because of advances in computing and related information technology. Once used by a handful of elite researchers in a few research communities on select problems, advanced computing has become essential to future progress across the frontier of science and engineering. Coupled with continuing improvements in microprocessor capabilities, converging advances in networking, software, visualization, data systems and collaboration platforms are changing the way research and education is accomplished.

Recognizing that cyberinfrastructure capabilities are essential to advances in all science and engineering fields, NSF has developed 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:

- Develop a stable, human-centered cyberinfrastructure (CI) that is driven by science and engineering research and education opportunities;
- Provide the science and engineering communities with access to world-class CI tools and services, including those focused on: high-performance computing and advanced networking; data, data analysis and visualization; virtual organizations; and learning and workforce development;
- Promote a CI that serves as an agent for broadening participation and strengthening the Nation's workforce in all areas of science and engineering; and
- Provide a sustainable CI that is secure, efficient, reliable, accessible, and usable, and which evolves as an essential national infrastructure for conducting science and engineering research and education.

OCI supports the development and deployment of cyberinfrastructure that is shared by all scientific and engineering disciplines, making possible potentially transformative basic research in areas such as nanotechnology, physics, chemistry, materials science, and engineering, as called for in the ACI. It also promotes interoperability between components of cyberinfrastructure both here in the U.S. and abroad.

About two thirds of NSF's investments in cyberinfrastructure are made by the directorates and offices responsible for fundamental domain specific research and education in science and engineering, while the remaining third, which is shared across all of NSF, is 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 cyberinfrastructure portfolio delivers the highest returns on the Nation's investment.

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

FY 2007 Request, OCI…………………………………………………………………………….$182.42

Discovery Research for Innovation +$10.58

- *Software and Services for Complex Science and Engineering (+$5.08 million).* OCI will support the development and provision of software and services that facilitate complex science and engineering research. The emphasis will be on software and services that enhance the utility and impact of NSF's parallel investments in high-performance computing and advanced network control and transport mechanisms. These include innovative approaches to the management of data collections; software and practices that enhance the semantic interoperability of data and tools; robust middleware that supports distributed applications, distributed collaboration, interactive remote observation, and the tele-operation of instruments and experimental facilities; as well as advanced data analysis and visualization tools. Such advances in the analysis and management of data from experiments and computational models are critical to advancing ACI goals in data-intensive areas such as nanotechnology, materials science, weather and climate prediction, and the prediction of hazards from events such as earthquakes and hurricanes.

- *Petascale application software development (+$3.50 million).* Supporting the development of numerical models, data analysis tools, new algorithms, and new programming paradigms that take full advantage of the very large-scale HPC systems becoming available over the next few years is a key element of NSF's HPC strategy. With advanced petascale applications, researchers will be able to determine the three-dimensional structures of proteins and study how structure influences function; examine the patterns of emergent behavior that occur in models of very large societies; study nucleosynthesis in supernovae; understand what sort of abrupt transitions can occur in Earth's climate and ecosystem structure and why these happen; pursue the capability to design catalysts atom-by-atom, potentially transforming industrial synthesis; find strategies that optimize the management of complex infrastructure systems; gain a better understanding of language processing in large assemblages of neurons; and facilitate the planning and response to natural and man-made disasters that prevent or minimize the loss of life and property. OCI support for petascale software development will focus on preparing computer codes, in strategic science and engineering research areas, to run effectively on petascale computing systems. This type of development is critical for the ACI goal of using world-leading computing capability to advance a broad range of science and engineering through modeling and simulation at unprecedented scale and complexity. OCI will collaborate with NSF's research directorates to identify the appropriate science and engineering research areas. OCI support of petascale application software development will leverage the support for fundamental research provided by these divisions and include co-investment opportunities.

- *Strategic Technologies for Cyberinfrastructure (+$2.0 million).* The current level of innovation in cyberinfrastructure is very high. In addition to providing robust cyberinfrastructure for science and engineering research, OCI will provide "venture capital" to researchers who wish to capitalize on new ideas emerging from computer science and elsewhere and to explore whether these have the potential to be the next revolutionary strategic technologies in cyberinfrastructure. As such technologies mature, they will contribute to strengthening the capabilities of computing systems and advanced networks, highlighted in the ACI, and to the provision of new tools for basic research.

Transformational Facilities and Infrastructure +$14.48

- *High Performance Computing: Operations and Maintenance (+$20.0 million).* Increased operations and maintenance funding will support the sustained operation of high-performance computing (HPC) systems in university supercomputing centers. Such centers provide access to HPC resources, coupled with sophisticated user support and training, to a diverse mix of researchers and educators in the academic community. These resources are used in innovative research in areas ranging from biology to social science. They also provide a bridge to the larger-scale computing systems being brought on-line in NSF's national supercomputing grid, the TeraGrid or Extensible Terascale Facility. The latter is a high-end computing capability that is coupled with advanced networking and is designed to enable scientific advances across a broad range of disciplines, as called for in the ACI.

- *Other Infrastructure and Tools (-$5.52 million).* Adjustments will continue to 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*. These include a transition from a centralized model for the provision of cyberinfrastructure development and services to a broader and more diverse portfolio of cyberinfrastructure developers and resource providers.

Preparing the Workforce of the 21st Century -$7.48

Integration of research and education through cyberinfrastructure. In collaboration with partners across the Foundation, OCI will support creative explorations and demonstrations of the use of cyberinfrastructure to integrate research with education, the development of innovative technologies that will facilitate the integration of research and education, and research on how educators and students interact with cyberinfrastructure. One aim of this support is to connect students and educators with the types of complex science and engineering that are becoming increasingly prominent in contemporary research, that are themselves being facilitated by cyberinfrastructure, and that are difficult to reproduce in a school laboratory or informal education setting using traditional methods.

Subtotal, Changes +$17.58

FY 2008 Request, OCI……………………………………………………..……………………$200.00

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 99 percent in FY 2006, 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) for the Division of Shared Cyberinfrastructure that preceded OCI was held in June 2005. The COV was composed of qualified external evaluators. 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. The COV found that: (i) the "merit review process is run with high integrity with appropriate care on criteria, consideration and judgment;" (ii) "reviews and summaries did an excellent job of addressing both quality and impact criteria;" and (iii) "the overall quality of accepted projects seems gratifyingly high."

The COV recommended:

- The development of a "long-term strategic vision for the integration of complementary activities across NSF" that included more attention to data-intensive applications, the use of service-oriented architectures to advance interoperability, and networking. NSF responded by developing the document, "NSF's Cyberinfrastructure Vision for 21st Century Discovery," inviting public comment, and incorporating this wider view in its plans for FY 2007 and FY 2008 investments;
- Remaining engaged in activities with promise for longer-term impact. The subsequent organizational realignment has created a clearer division of responsibilities with OCI focusing primarily on near-term development, deployment and sustaining infrastructure and CISE focusing on longer-term research activities; and
- The establishment of an external panel to provide advice on strategic directions in cyberinfrastructure. NSF has subsequently chartered such a committee, the Advisory Committee for Cyberinfrastructure (ACCI).

In partnership with NSF's directorates and offices, the ACCI provides guidance on issues such 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 meets twice a year. Members from both academe and industry represent a cross section of the science and engineering field, with representatives from many different disciplines. The ACCI includes a balanced representation of women, underrepresented minorities, and individuals from a range of geographic regions and institutions.

PERFORMANCE

The FY 2008 Budget Request is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals highlighted in the FY 2006-2011 Strategic Plan. These goals were designed as a mechanism to better enable assessment of program performance and to facilitate budget and performance integration.

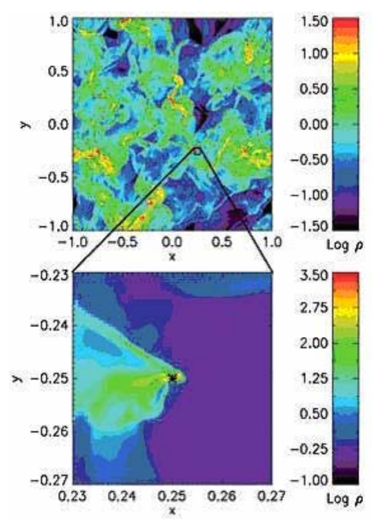
Office of Cyberinfrastructure
By Strategic Outcome Goal
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Discovery	$9.85	$4.17	$14.75	$10.58	253.7%
Learning	11.48	11.48	4.00	-7.48	-65.2%
Research Infrastructure	103.76	164.72	179.20	14.48	8.8%
Stewardship	2.05	2.05	2.05	-	-
Total, OCI	$127.14	$182.42	$200.00	$17.58	9.6%

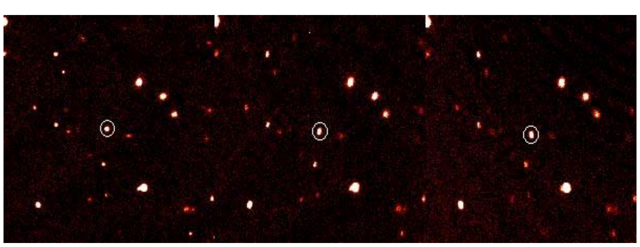
Totals may not add due to rounding.

Recent Research Highlights

► **A Star is Born:** Astrophysicist Richard Klein of the University of California, Berkeley, and his colleagues have carried out a series of massive computer simulations that greatly clarify our understanding of how stars form inside immense clouds of interstellar gas. Astronomers have long agreed on the basics. Stars form in the clouds because gravity pulls the gas into clumps, which eventually become so hot and so dense they ignite by thermonuclear fusion. But there has been much less agreement on the details. Do stars form all at once, as in the "gravitational collapse" model? Or do they start small and then grow over time, as in the "competitive accretion" model? To find the answers, Klein and his colleagues have developed the first computer simulation that can fully take into account the complex motions within a collapsing cloud. The researchers had to run their simulation for nearly two weeks on one of the most powerful machines in the world: the San Diego Supercomputer Center's DataStar system, which has a total memory of 7.3 trillion bytes, and is capable of 15.6 trillion arithmetic operations per second. The result was a victory for the gravitational collapse model. Competitive accretion cannot account for what's observed, either in the simulation or in the observations.



Top figure shows a slice through a star formation region, with densest areas shown in red. The key finding, shown in the zoom-in (bottom), is that once a protostar forms, creating a dense wake behind it (left), the turbulent wake prevents the protostar from gaining much additional gas from the surrounding clump, as required by the competitive accretion theory. *Credit: Mark Krumholz, Princeton U.*

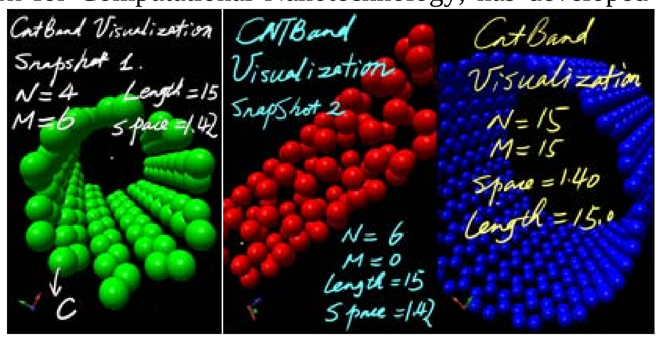


These time-lapse images of a new found planet in our solar system were originally taken in October 2003, using the Samuel Oschin Telescope on Mt. Palomar. The planet, circled in white, is seen moving across a field of stars. The three images were taken about 90 minutes apart. *Credit: Hans-Werner Braun.*

► **What do the discovery of a new planet and fighting large-scale wildfires have in common?:** The NSF-funded High Performance Wireless Research and Education Network (HPWREN) is a prototype system now operating in California's San Diego and Riverside counties. HPWREN is partly intended as a testbed for several of NSF's large-scale sensor network initiatives. These include EarthScope, the Ocean Observatories Initiative, the National Ecological Observatory Network, and the Network for Earthquake

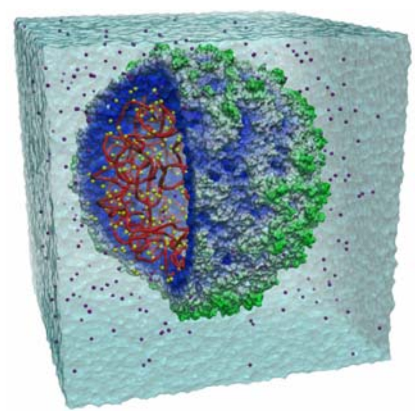
Engineering Simulation. At the same time, however, HPWREN is a working system, with multiple remote sites that are providing high-speed Internet access to field scientists in a variety of disciplines. Recently, astronomers from around the world used HPWREN to analyze the flood of data produced by a 161-megapixel camera at the Palomar Observatory — and in the process, discovered another "planet" in our solar system. Other remote HPWREN nodes include seismometers and ecological sensors. HPWREN also serves the first-responder community. For example, the California Department of Forestry and Fire Protection routinely accesses HPWREN's mountaintop cameras and sensors to monitor the notoriously fire-prone region. Firefighters at the scene of a blaze can rapidly deploy a wireless HPWREN node to access maps, aerial imagery, and telemetry data. Finally, HPWREN provides educational opportunities for rural Native American learning centers and schools in the area. Many other applications are described on the HPWREN Web site: http://hpwren.ucsd.edu.

► **Cyberinfrastructure education for future nanotechnologists:** The nanoHUB, operated by an NSF-funded research consortium known as the Network for Computational Nanotechnology, has developed next generation cybertools that encourage students to do collaborative simulations of nanoscale systems on tablet PCs and mobile devices. The nanoHUB has also deployed video and audio podcasts that facilitate anytime, anywhere learning. The video podcasting service on the nanoHUB has attracted over 1,000 downloads in just 2 months, suggesting that there is indeed a demand for such content. In order to measure the impact of such tools on learning, the nanoHUB team is integrating the assessment engine of the open-source Sakai Collaboration and Learning Environment using web services, a technology at the core of the nanoHUB middleware.

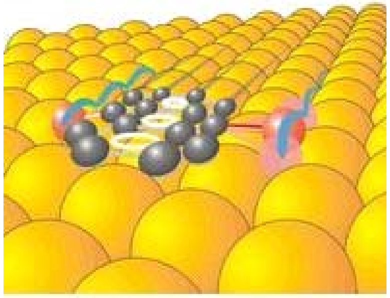


Ink-based interfaces to simulations that facilitate better student collaboration. *Credit: Krishna Madhavan and Sebastien Goasguen, Purdue.*

► **The first atom-by-atom simulation of a life-form:** For the first time, researchers have visualized the changing atomic structure of a virus by calculating how each of the virus' one million atoms interact with each other every femtosecond--or one-millionth-of-a-billionth of a second. The researchers' hope is that the insights gained from such simulations may one day help us combat viral infections in plants, animals and even humans. Using a supercomputer at the NSF-funded National Center for Supercomputing Applications (NCSA), the team ran the simulation about 100 days to generate just 50 nanoseconds of virus activity. For comparison, notes team leader Klaus Schulten of the University of Illinois at Urbana-Champaign, it would have taken the average desktop computer 35 years to come up with the results. The simulation revealed key physical properties of satellite tobacco mosaic virus, a very simple, plant-infecting virus. Ultimately, using the next generation of "petascale" supercomputers, scientists hope to generate longer simulations from bigger biological entities. The National Institutes of Health also provided support for this study.



The first all-atom simulation of a satellite tobacco mosaic virus. *Credit: University of Illinois at Urbana-Champaign's Theoretical and Computational Biophysics Group.*



Propelled by two sulfur (red) atoms as feet, DTA 'walks' across the surface setting step in front of step and never veering off course. *Credit: Ludwig Bartelis, UC – Riverside.*

► **Walking Molecule Provides a Key to "Molecule Memory:"** UC Riverside professor Ludwig Bartels and his team have designed and simulated a molecule that can "walk" across a flat surface in a straight line. Indeed, 9,10-dithioanthracene (DTA), as the molecule is known, can walk for more than 10,000 steps on molecular appendages that act as feet. Such a DTA "nano-walker" could form the basis of a molecular memory 1,000 times more compact than current computer memory devices. That, in turn, could make it important to the nascent field of "molecular computing." The new concept of molecular propulsion may also have far reaching benefits for the development of surface nano-robots, with applications ranging from information storage to the control of surface chemical reactions. The molecule design and simulations were done using one of the TeraGrid's supercomputers located at the San Diego Supercomputing Center.

► **Industrial Partnerships through the National Science Foundation's Supercomputing Resources:** Forty companies participated in a study involving NSF supercomputing resources. The study concluded that the partnership between the NSF Centers and the U.S. businesses "… clearly has been successful." The HPC resources were utilized at the centers to advance the industrial research and development efforts, advance strategic work, develop new products, solve specific problems and to get products to market more rapidly. Benefits were characterized as both financial and from a competitive perspective. The results obtained were identified to be beneficial in the areas of increased revenue growth, increased market share and the ability to respond to actual competitive threats. Several of the industrial users were able to assign a dollar value to their relationships, ranging from $100,000 to $57 million. Further, more than half of the participants reported that their partnerships had resulted in "… a breakthrough or discovered something totally new." This is a significant finding in today's global market-place where innovation can often provide a competitive advantage. Identified as a principal reason for entering into the partnership was access to the scientific and HPC expertise available at the centers, with actual access to the HPC resources themselves coming in as next in significance. Finally, 15 of the industrial users installed HPC systems after their experience with the centers.

Other Performance Indicators

The table below shows an estimate of the number of people benefiting from OCI funding based on the types and number of awards.

Number of People Involved in OCI Activities

	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Senior Researchers	339	350	360
Other Professionals	439	450	515
Postdoctorates	16	20	25
Graduate Students	136	145	175
Undergraduate Students	85	90	90
Total Number of People	1,015	1,055	1,165

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 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Statistics for Competitive Awards:			
Number	42	60	50
Funding Rate	32%	20%	18%
Statistics for Research Grants:			
Number of Research Grants	34	55	50
Funding Rate	28%	18%	18%
Median Annualized Award Size	$253,000	$255,000	$190,000
Average Annualized Award Size	$287,000	$270,000	$210,000
Average Award Duration, in years	2.6	2.7	2.8

OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING $45,000,000

The FY 2008 Budget Request for the Office of International Science and Engineering (OISE) is $45.0 million, an increase of $4.39 million, or 10.8 percent, over the FY 2007 Request of $40.61 million.

Office of International Science and Engineering Funding

(Dollars in Millions)

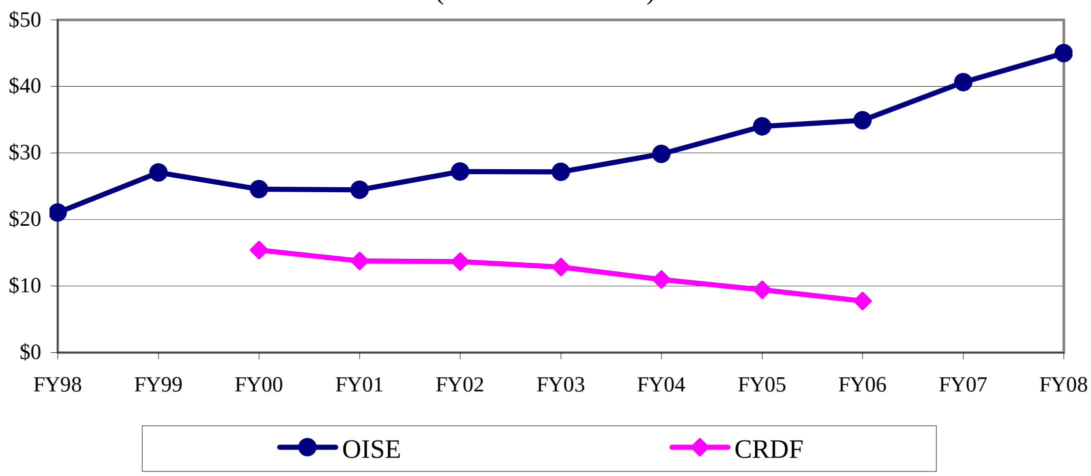
	FY 2006 Actual[1]	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Office of International Science and Engineering	$42.61	$40.61	$45.00	$4.39	10.8%

[1] FY 2006 Actual includes $7.73 million in additional funds provided by the U.S. Department of State for an award to the U.S. Civilian Research and Development Foundation (CRDF).

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.

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), FY 2005 ($9.42 million) and FY 2006 ($7.73 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 mathematical sciences and 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 Major Changes in Office-wide Investments ***(Dollars in Millions)***

FY 2007 Request, OISE..$40.61

Discovery Research for Innovation +$.79

- *Disciplinary and Interdisciplinary Research ($500,000).* OISE will invest $500,000 in new funding for highly meritorious research activities that, due to the critical and integral role of foreign research partners, present unique risks and offer potentially high payoff.

- *Cyber-enabled Discovery and Innovation ($290,000).* Cyberinfrastructure and computational capabilities play a key role in fostering new scientific and engineering discoveries – whether domestically or through international partnerships. OISE will commit $290,000 in new funding for Cyber-enabled Discovery and Innovation (CDI).

Preparing the Workforce of the 21st Century +$3.60

OISE makes significant investments in building and strengthening the current and future pool of scientists and engineers by providing research and education opportunities where early-career researchers can develop the needed skills to operate effectively at the international level. In FY 2008, OISE will invest new funding to augment OISE-managed and other NSF programs in order to provide international research experiences for students, researchers, and teachers – specifically:

- *International Research Experiences for Students ($650,000).* Expand in FY 2008 OISE's investment by $650,000 to $2.65 million. This increase will support approximately 100 more U.S. undergraduate and graduate students by providing early-career growth opportunities through international cooperative research training and networking and mentoring.

- *International Research Fellowship Program ($600,000).* Augment funding by $600,000 to bring the program's annual investment total to $4.10 million. The additional funding will support approximately 4 to 5 more post-doctorate students.

- *East Asia and Pacific Summer Institute Program ($1,550,000).* Increase funding by $1.55 million to total $2.70 million, to expand the program on three fronts. First, OISE will enlarge the number of students accepted into the program; secondly, the number of participating partner host countries will increase to a total of seven in FY 2008; finally, OISE will raise the program's per student stipend to a level commensurate with other NSF stipends.

- *Dissertation Enhancements ($300,000).* Expand OISE's investment by $300,000 for a total annual investment for dissertation enhancements to $350,000. This increase will provide approximately 10 to 15 dissertation enhancements and supplements to enable graduate students to gain first-hand experience conducting research overseas.

- *Research Experiences for Teachers ($500,000).* Allocate $500,000 in new funding to provide international research experiences for approximately 50 K-12 science and math teachers.

Subtotal, Changes +$4.39

FY 2008 Request, OISE..$45.00

OISE Priorities for FY 2008

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 2008 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 both programs managed by OISE and investments made in partnership with other NSF directorates and offices. Approximately 51 percent of OISE's portfolio is available for all new awards each year while approximately 30 percent of OISE's portfolio is available for new research grants. The remainder is used primarily to fund awards made in previous years.

Specific emphases in FY 2008 are to:

- Continue major investments to promote research excellence through international collaboration. OISE will continue to invest in the Partnerships for International Research and Education program. OISE will partner with other NSF research directorates and offices and foreign research organizations to catalyze research in support of the International Polar Year. OISE will maintain its overall investment in cyber-related 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 providing supplemental and co-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 through OISE-managed and other NSF programs. Supported programs and activities will include: the International Research Experiences for Students; the East Asia and Pacific Summer Institutes for U.S. Graduate Students; the Pan-American Advanced Studies Institutes; 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.

- 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 Scientific Unions, and International Institute for Applied Systems Analysis.

- Continue efforts to expand networks between the U.S. research community and those in developing countries as well as to identify new opportunities for collaboration.

NSF-WIDE INVESTMENTS

In FY 2008, OISE will support research and education efforts related to broad, Foundation-wide investments.

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. OISE investments in these NSF-wide investment areas 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 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Biocomplexity in the Environment	$0.20	$0.13	-	-$0.13	-100.0%
Cyber-enabled Discovery & Innovation	-	-	0.29	0.29	N/A
Cyberinfrastructure	1.00	1.05	0.75	-0.30	-28.6%
Human and Social Dynamics	0.50	0.50	0.50	-	-
International Polar Year	-	0.30	0.40	0.10	33.3%

Biocomplexity in the Environment: With the conclusion of this priority area in FY 2007, key components of investment in this area will be transferred to core programs for continued support.

Cyber-enabled Discovery and Innovation: OISE will maintain its investment in cyber-related research. In FY 2008, OISE will fund $290,000 for Cyber-enabled Discovery and Innovation research.

Cyberinfrastructure: OISE will fund $750,000 in cyberinfrastructure (a $300,000 decrease from the $1.05 million FY 2007 funding level). OISE will coordinate with NSF directorates and offices to ensure that the international dimensions of cyberinfrastructure are highlighted and developed.

Human and Social Dynamics: OISE will maintain its funding level of $500,000 for this investment area where the potential for international collaboration is rapidly expanding.

International Polar Year: 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 increase its investment for IPY-related programs to $400,000 — an increase of $100,000 from FY 2007.

Opportunities to support U.S. participation in international collaboration in the areas of the **nanotechnology**, **networking and information technology**, **climate change,** and **homeland security** have been targeted in the past. OISE will continue to consider funding new opportunities in these areas 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 52 percent in FY 2006 and is estimated at 60 percent in FY 2007 and 55 percent in FY 2008. The majority of projects that did not undergo external review were supplements that added an international dimension to projects already reviewed and funded by 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, under-represented minorities, and geographic regions.

PERFORMANCE

The FY 2008 Budget Request is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals stated in the FY 2006-2011 Strategic Plan. These goals provide an overarching framework for progress in fundamental research and education and facilitate budget and performance integration.

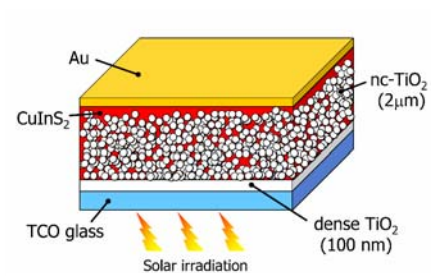
Office of International Science and Engineering
By Strategic Outcome Goal
(Dollars in Millions)

	FY 2006	FY 2007	FY 2008	Change over FY 2007 Request	
	Actual	Request	Request	Amount	Percent
Discovery	$30.11	$29.26	$30.05	$0.79	2.7%
Learning	9.91	9.00	12.60	3.60	40.0%
Research Infrastructure	0.59	-	-	-	N/A
Stewardship	2.00	2.35	2.35	-	-
Total, OISE	$42.61	$40.61	$45.00	$4.39	10.8%

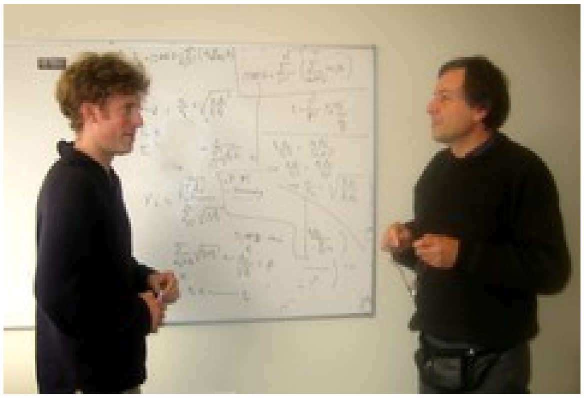
Totals may not add due to rounding.

Recent Research Highlights

► **Improving Solar Cell Performance:** Modern science is increasingly a global endeavor, and sometimes U.S. researchers need to go abroad to pursue a unique line of research. Recently, for example, NSF's International Research Fellowship Program gave Stanford graduate student Ryan P. O'Hayre a chance to follow his interests to the Technical University of Delft in the Netherlands, where scientists were investigating a novel type of solar cell that promises far lower cost than traditional silicon-based alternatives. The Dutch lab was working on problems with "bulk-heterojunction" solar cells that generate electric current from the energy of sunlight. These devices are made from inexpensive materials using comparatively low-cost fabrication methods. But these methods typically tend to produce defective, low quality films, thus reducing the cell's efficiency. At Delft, O'Hayre's research focused on cells using titanium dioxide – a workhorse compound found in light-sensitive applications from house paint to sunscreen. O'Hayre's group found that cells made from larger TiO_2 particles outperformed cells made from smaller particles. This discovery, along with recent results from other researchers, suggests that design changes could improve bulk-heterojunction solar cell performance, dramatically improving efficiency. O'Hayre and colleagues published multiple papers on their findings. O'Hayre earned his doctorate and took a position at the Colorado School of Mines, in order to work closely with the National Renewable Energy Laboratory and the Colorado Fuel Cell Center.



Structure of a TiO2/CuInS2 bulk-heterojunction solar cell. *Credit: R. O'Hayre*



Andy Klein, a Cornell University doctoral student, works with Pierre Duhamel of Supélec in Paris on overcoming wireless communication problems. *Credit: Andy Klein*

► **U.S. - France Collaboration Sparks Multiple Successes:** International research collaboration can improve communications in more ways than one. Andy Klein's experience is a case in point. As a graduate student at Cornell, an NSF grant enabled him to participate in a research project between Cornell University and two French institutions: the French National Institute for Telecommunications and Supélec. At the French institutes, Klein was immersed in cutting-edge research focused on some of the most difficult problems in wireless communications – extending range and reliability. In particular, he worked on ways to counteract the "multipath" distortion that results when electromagnetic waves reflect off different surfaces. That phenomenon is perhaps most familiar as the cause of "ghost" images on TV sets with antennas. Klein and colleagues published jointly submitted papers, and Klein soon earned his doctorate. The work will allow portable, personal communication devices to communicate successfully in a wider range or environments and permit longer battery life. The experience produced ideas that Klein used in his thesis; however it also created another kind of communication: "The non-technical aspects of the collaboration were perhaps even more rewarding," Klein says, "since I was presented with a fresh perspective on how research can be conducted, from funding issues to topic selection. This alternate perspective gave me a reference point through which to better judge aspects of the American research system – a system for which I now have even more appreciation."

► **Imaging the African Superplume while building U.S.-African partnerships and enhancing diversity in geosciences:** U.S. scientists and students have partnered with African colleagues to examine the Earth's mantle below Africa, where it forms a structure known as the African Superplume. As part of a broad initiative called "AfricaArray," the group is imaging the African Superplume to provide insights into how it formed. This region in the African lower mantle may hold the key to unraveling the dynamics of mantle convection, which brings warm material to the surface and sends cooler material to the interior. The project, which is in its initial year, is funded through NSF's Partnership for International Research and Education program, and supports researchers from Pennsylvania State University and North Carolina A&T University to work with scientists in Botswana, Ethiopia, Kenya, Namibia, South Africa, Tanzania, Uganda, Zambia, and Zimbabwe. The program has a unique model for graduate education, which requires students to take a foreign language, spend one semester at a university in Africa, undertake international field research, and develop tutorials of introductory geophysics topics for undergraduates. The participants are also developing new e-education courses for U.S. and African students. The program has run its first workshop for North Carolina high school teachers, providing them with information and educational materials about seismology, earth structure, plate tectonics, and African geology.

Students (U.S.-left; African-right) working on an electrical resistivity survey during a summer geophysics field course in Africa. *Credit: Paul Dirks*

Other Performance Indicators

OISE funding supports a significant number of individuals with a focus on early-career researchers. In FY 2006, awards managed by OISE supported estimated totals of 445 postdoctoral researchers, 1022 graduate students, and 539 undergraduates. OISE's East Asia and Pacific Summer Institutes program alone placed 143 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 38 postdoctoral fellows from 18 states in 23 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 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Senior Researchers	259	245	250
Other Professionals	31	40	75
Postdoctorates	65	80	70
Graduate Students	86	110	110
Undergraduate Students	37	70	45
Total Number of People	478	545	550

[1] This table shows salary and stipend support awards managed by OISE only. People supported through co-funded awards that are managed by other directorates are not included in the above numbers but rather in respective directorate figures.

The funding rate for competitive awards in FY 2008 is estimated to remain relatively unchanged.

OISE Funding Profile

	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Statistics for Competitive Awards:			
Number	320	310	350
Funding Rate	45%	40%	40%
Statistics for Research Grants:			
Number of Research Grants	83	85	90
Funding Rate	27%	25%	20%
Median Annualized Award Size	$32,500	$35,000	$30,000
Average Annualized Award Size	$57,787	$100,000	$50,000
Average Award Duration, in years	2.1	2.4	2.6

NOTE: The spike in the average annualized award size in FY 2007 is due to the Partnerships for International Research and Education competition in that year.

OFFICE OF POLAR PROGRAMS $464,900,000

The FY 2008 Budget Request for the Office of Polar Programs (OPP) is $464.90 million, an increase of $26.80 million, or 6.1 percent, over the FY 2007 Request of $438.10 million.

Office of Polar Programs Funding

(Dollars in Millions)

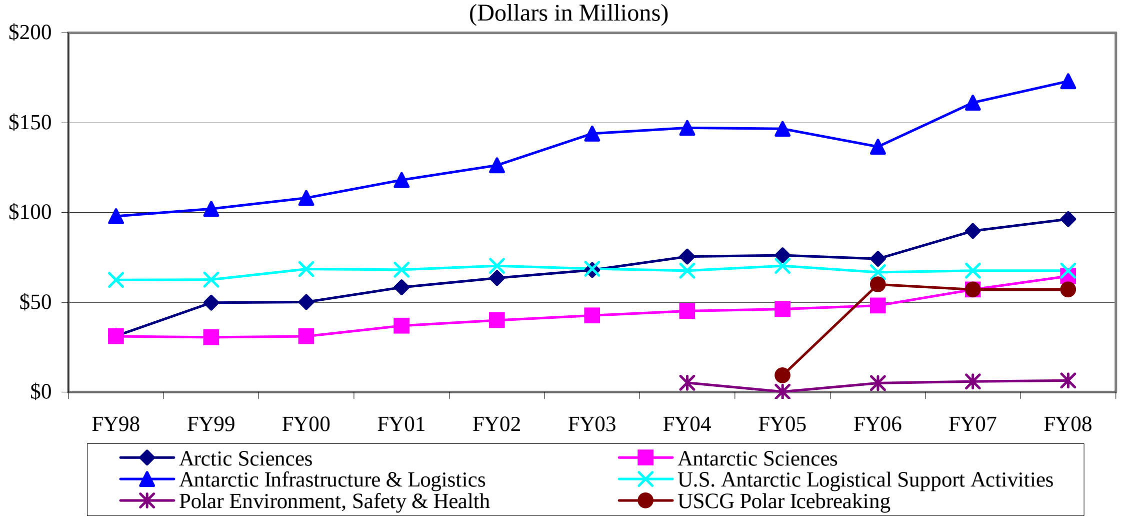
	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Arctic Sciences (ARC)	$74.21	$89.59	$96.27	$6.68	7.5%
Antarctic Sciences (ANT)[1/]	48.21	56.98	64.49	7.51	13.2%
Antarctic Infrastructure & Logistics (AIL)	203.17	228.61	240.66	12.05	5.3%
U.S. Antarctic Logistical Support Activities	*66.66*	*67.52*	*67.52*	-	-
Polar Enviroment, Safety & Health (PESH)	5.01	5.92	6.48	0.56	9.5%
USCG Polar Icebreaking	59.94	57.00	57.00	-	-
Total, OPP	$390.54	$438.10	$464.90	$26.80	6.1%

Totals may not add due to rounding.

[1/] The Science & Technology Center for Remote Sensing of Ice Sheets is included in the Antarctic Sciences Division.

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 key 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 abrupt or potential future change. An additional area of forefront research probes how organisms have adapted to the extreme polar environment. Since FY 2006, NSF has had the responsibility for funding the cost of U.S. Coast Guard (USCG) icebreakers that support scientific research in polar regions.

OPP Subactivity Funding
(Dollars in Millions)



NOTE: US Antarctic Logistical Support Activities are shown separately from the Antarctic Infrastructure & Logistics Division, where it is administered.

RELEVANCE

Research in polar regions 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. In addition, it 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. OPP funding will support the development and implementation of the enhanced observation systems needed to trace these shaping influences on a regional basis. It will also support research to elucidate the interactions among them and how they impact the polar environment. The work will include studies 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. The latter include 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. NSF is also responsible for several international research partnerships in polar regions.

<u>International Polar Year:</u>

In FY 2008, NSF will continue funding for International Polar Year (IPY) 2007-2009 research, infrastructure and education. 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 will continue to provide U.S. leadership in IPY through the work of its grantees, in coordination with other agencies, and by developing partnerships with other nations. In FY 2006, emphasis was placed on establishing an Arctic Observing System in support of the Study of Environmental ARctic CHange (SEARCH), on Polar Ice Sheet Dynamics and Stability, and on studies of Life in the Cold and Dark, particularly at the genomic level. Work in FY 2007 and FY 2008 builds on these themes and expands to new ones identified in research community planning activities. These include understanding and characterizing environmental change through studies of systems and drivers, impacts on subsystems, and interactions among components.

Another focus of IPY will be the maintenance of existing standardized data sets, creating new scientific collections, and ensuring their availability to current and future generations of researchers. These will help frame the answers to current and as yet unknown questions. Led by NSF's Office of Polar Programs, several of NSF's disciplinary-based research directorates, NSF's Directorate for Education and Human Resources, and the Office of International Science and Engineering will participate actively in this work. As stated in the President's announcement on the ACI, "the bedrock of America's competitiveness is a well-educated and skilled workforce," which is emphasized in NSF's mission. IPY provides an ideal opportunity to advance this goal by involving students in the international research venture.

Summary of Major Changes by Division

FY 2007 Request, OPP…………………………………………………………………………... $438.10

Arctic Sciences +$6.68

Increased funding for a broad range of studies on and about the Arctic environment and basic processes, including study of significant, Arctic system-scale environmental change and its human dimension.

Antarctic Sciences +$7.51

Increased support to begin ramp-up of scientific operation and research utilizing the IceCube Neutrino Observatory; increased emphasis on development of instrumentation for critical observations of the Antarctic, including the ice sheet, the underlying continent, and the surrounding ocean and atmosphere; increased support for observation, analysis, and modeling associated with International Polar Year research.

Antarctic Infrastructure & Logistics +$12.05

Increased funding focuses on continuing investments in activities to improve the resupply capability to support McMurdo and South Pole Stations. Major investments in this area include completion of the project to increase bulk fuel storage at McMurdo Station and the procurement of inland traverse equipment. Other priorities include increased communications capability for South Pole Station and replacement of the Palmer Station pier.

Polar Environment, Safety & Health +$0.56

Funding will support efforts to further modernize medical, dental, and safety capabilities for Arctic and Antarctic field science.

USCG Polar Icebreaking +$0.00

Since FY 2006, NSF has been responsible for funding the USCG's three polar icebreakers. While costs for fixed expenses such as personnel will increase, maintenance costs are expected to decrease. Therefore, overall costs are expected to remain the same in FY 2008.

Subtotal, Changes +$26.80

FY 2008 Request, OPP…………………………………………………………………… $464.90

Summary of Major Changes in Office-Wide Investments ***(Dollars in Millions)***

FY 2007 Request, OPP……………………………………………………………............ $438.10

Discovery Research for Innovation +$4.79

Remote Sensing Instrumentation (+$2.0 million)

Support development of instrumentation (sensors, communications, etc.) and equipment for making critical scientific observations, either as remote installations, as sensors mounted on vehicles or aircraft, or as instruments critical for the scientific analysis of recovered samples. This will create opportunities for all areas of Antarctic science.

IceCube Neutrino Observatory (+$2.79 million)

IceCube exemplifies the ACI's emphasis on development of unique facilities and instruments that enable discovery and advancement. 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. The IceCube Neutrino Observatory is expected to be fully operational in FY 2011, with segments of the detector transitioning to operations as they are completed. Science operations and research costs will be shared by the collaborating institutions, domestic and foreign. Funding is requested in FY 2008 for initial science operations (+$1.50 million) and scientific exploitation (+$1.29 million) as the Antarctic Sciences Division's part of the partnership with the Physics Division.

Transformational Facilities and Infrastructure +$15.61

U.S. Antarctic Program Resupply (+$15.05 million)

Accelerate projects to diversify resupply of the USAP, including the final increment for increasing fuel storage capacity at McMurdo (+$6.10 million, providing a two-year capacity in the event of a ship-borne resuppply failure), Palmer Pier replacement (+$2.17 million, ensuring continuity of pier-side cargo and personnel embarkation/debarkation), and alternative methods of resupplying South Pole Station via air and ground (+$6.78 million, including traversing materials from McMurdo in order to reduce the cost of delivery and the number of required LC-130 flights).

South Pole Infrastructure (+$2.0 million)

Increase power generation capability and fuel storage at South Pole Station to support new science projects.

USAP IT Network (+$1.0 million)
Begin replacement of legacy software systems, which have become unsupportable and are incompatible with current requirements to safeguard data and personal information.

Environment, Safety & Health (+$0.56 million)
Increase funding for safety and health measures in remote field research and program oversight, includes adopting electronic medical records systems, enhancing telemedicine capabilities, and reviewing medical standards and guidelines.

South Pole Telescope (+$2.0 million)
The South Pole Telescope (SPT) is another example of the investments OPP is making to provide researchers with the facilities and instruments required to further scientific discovery. Research conducted using this telescope will test fundamental theories about the origin of the universe and advance understanding of the nature of dark energy and dark matter, which are now thought to be the major components of the universe. SPT will begin operation in FY 2007 and be completely operational in FY 2008. Funds in FY 2008 will be used to deliver and install the final components of the telescope.

Defer Williams Field Runway relocation in order to fund the completion of the South Pole Telescope as described above. (-$2.0 million)

Completed Projects (-$3.0 million)
As projects are completed or near completion, funds are reallocated to ongoing projects or to new projects that are described below. The SHALDRIL project is ending, and there will be cost reductions in the Microwave Landing System and McMurdo Bandwidth projects.

<u>International Polar Year (IPY) Leadership</u> +$6.40

IPY Logistics (-$5.0 million)
IPY logistics spending decreases as IPY logistics funding peaks in FY 2007 to enable polar research and education projects for both years of IPY.

IPY Research (+$5.0 million)
An increase in IPY research funding is made possible by the advanced funding of IPY logistics described above.

Climate Change Research (+$5.70 million)
Accelerate climate change research and the associated observing and modeling systems, with increased emphasis on human impacts. These projects foster advancement, collaboration and innovation on the complex scientific inquiry into climate change, involving and strengthening international partnerships to accelerate the progress of science worldwide.

Life in the Cold and Dark (+$0.70)

Adding to initial investments made during FY 2006-07, fund infrastructure and logistics to enable winter research at the LTERs at Toolik Field Station, Alaska and Summit, Greenland. Essentially nothing is known about how living organisms function in extreme polar environments once winter darkness and cold commence, because scientists have been unable to gain access to these regions during these times. These investments would introduce limited capability for access, opening up new opportunities for fundamental research concerning adaptations and other processes.

Subtotal, Changes +$26.80

FY 2008 Request, OPP……………………………………………………………………… $464.90

NSF-WIDE INVESTMENTS

In FY 2008, the Office of Polar Programs 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.

OPP NSF-wide Investments
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Biocomplexity in the Environment	$0.77	$0.83	-	-$0.83	-100.0%
Climate Change Science Program	10.50	10.50	10.50	-	-
Cyberinfrastructure	26.24	26.24	26.24	-	-
Human and Social Dynamics	0.20	0.20	0.20	-	-
International Polar Year	10.00	47.27	47.27	-	-
Mathematical Sciences	0.20	0.10	-	-0.10	-100.0%

Biocomplexity in the Environment: This priority area ends in FY 2007. With the conclusion of this priority area, key components of investment for bio/ecosystem studies will be transferred to core programs for continued support.

Climate Change Science Program: This 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. OPP focuses on climate change in the polar regions, as well as interactions with global climate.

Cyberinfrastructure: 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 environmental 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: This priority area 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: The IPY activities 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: This priority area ends in FY 2007. With the conclusion of this priority area, key components of investment in mathematic modeling will be transferred to core programs for continued support.

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 2006, 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 (COV), 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 Arctic Sciences and the Antarctic Sciences divisions conducted COVs during FY 2007.

OPP also receives advice from the Office of Polar Programs Advisory Committee (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

The FY 2008 Budget Request is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals stated in the FY 2006-2011 Strategic Plan. These goals provide an overarching framework for progress in fundamental research and education and facilitate budget and performance integration.

Office of Polar Programs
by Strategic Outcome Goal
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request	
				Amount	Percent
Discovery	$85.46	$92.45	$106.48	$14.03	15.2%
Learning	4.63	6.43	5.39	-1.04	-16.2%
Research Infrastructure	299.26	336.93	350.74	13.81	4.1%
Stewardship	1.18	2.29	2.29	-	-
Total, OPP	$390.54	$438.10	$464.90	$26.80	6.1%

Totals may not add due to rounding.

Recent Research Highlights

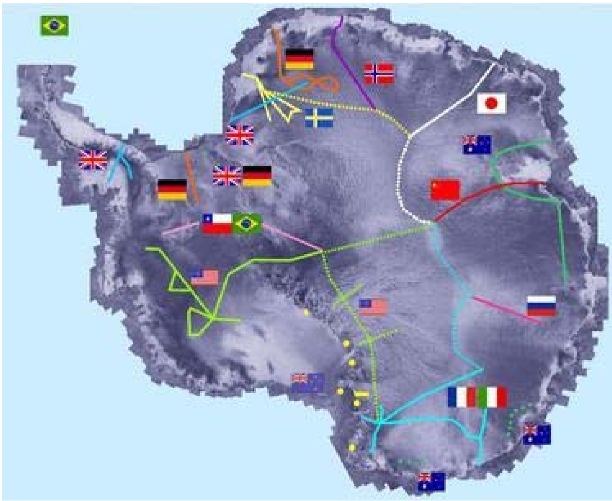
► **New Antarctica Museum Exhibition:** One of America's warmest locations has become an educational doorway to the coldest place on Earth. The Louisiana Museum of Natural History opened a new exhibition called "Experience Antarctica," designed by three NSF awardees at Louisiana State University (LSU). Aimed at K-12 students, it is housed in a Quonset-hut-shaped structure with corrugated walls to enhance the Antarctic feel, and features frost on the windows, sounds of a frigid wind howling outside, and 10 hands-on educational stations that provide information about Earth's southernmost continent.

Students at the "Experience Antarctica" exhibit.
Credit: Dr. Sophie Warny, LSU

Topics include the effect of plate tectonics on Antarctica's present state, paleontology (such as the presence of fossil dinosaurs on the continent), climate change and sea-level rise, geography and changing daylight at the bottom of the world, geology, astronomy and environmental concerns, among others.

The LSU group designed the program as part of the research community's commitment to the broader impacts of NSF-funded projects. The main LSU Principal Investigator involved, Sophie Warny, also participated in "SciGirls" — summer-camp science programs jointly sponsored by PBS Kids, Dragonfly TV and Louisiana Public Broadcasting. The three week-long sessions focused on women with careers in a number of scientific fields. (ANT)

► **ITASE (International Trans Antarctic Scientific Expedition):** Starting in 2005, a major NSF-supported Antarctic research program will move into new territory. The International Trans-Antarctic Scientific Expedition (ITASE) is a 20-nation consortium of researchers whose members have been traversing the Antarctic for years, gathering data on changes in ice mass, atmospheric chemistry, ocean and air circulation, temperature variation and cycling of carbon, nitrogen and sulfur — to name only a few. Eventually, scientists hope to create a comprehensive record of conditions on the continent over the past few hundred years.



ITASE traverse routes overlaid on Radarsat imagery. *Credit*: *SCAR ITASE Project Office, Climate Change Institute, University of Maine*.

The U.S. part of the effort (US ITASE, funded by NSF) has previously concentrated on West Antarctica, where American scientists had a long-standing research effort. But during the 2006-2008 austral field seasons (roughly November to February), US ITASE will extend its traverses into East Antarctica.

The West Antarctic phase of US ITASE resulted in many important insights, including:

- Temperatures are still within the range of natural variability of the last 200 years, except on the Antarctic Peninsula, and are closely associated with changes in major atmospheric circulation patterns.
- Mass balance variability is primarily controlled by the topography at the junction of ice and underlying rock.
- Much of the natural variability in the westerly wind strength is attributed to decadal and longer scales of solar variability that impact production of ozone and the temperature gradient over Antarctica and the Southern Ocean.

US ITASE traverse platform. *Credit*: *SCAR ITASE Project Office, Climate Change Institute, University of Maine.*

Data collected by US ITASE and its international partners are available to a broad scientific community and will contribute to many of the goals of the International Polar Year (IPY) 2007-2009. US ITASE has an extensive program of public outreach and provides significant opportunities for many students to experience multidisciplinary Antarctic research. (ANT)

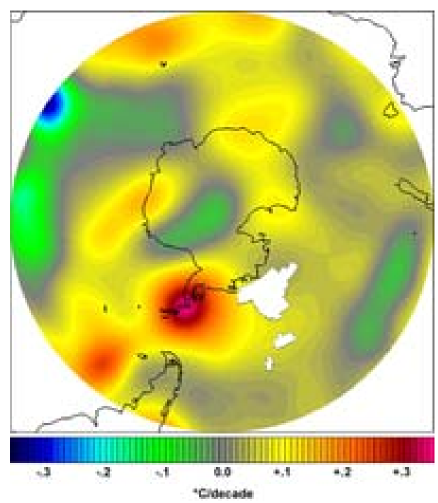
► **Northern Science Education:** Students from dense urban areas too often lack the opportunity to work and study in international field settings. The Northern Science Education project in Iceland is designed to fill that need. As one of NSF's Research Experiences for Undergraduates programs, it provides a way for students from the inner city (primarily from the City University of New York, many of whose students come from populations underrepresented in science) to experience a variety of science disciplines at active research sites in a foreign country.

Students of the Northern Science and Education REU excavate an archaeological site in Iceland. *Credit*: *Dr. Sophia Perdikaris, City University of New York Brooklyn College.*

The Northern Science Education (NSE) project brings undergraduates to an archaeological field site where researchers are investigating the relationships among climate, environment, and the ancient inhabitants of Iceland. The project works closely with the Archaeological Institute of Iceland and provides opportunities for students to interact with their Icelandic peers. Prior to the field season, students are given classroom training in the relevant scientific fields, including intensive laboratory training and special internships through the American Museum of Natural History in New York City.

During the field season students continue "classroom" lectures in archaeology, paleoethnobotany, and geology/glaciology, which supplement their field data collection. Each student has an individual project that is formulated and carried out during the season in Iceland. Once they return to their home institutions, they analyze the data, write papers (several of which have been published in peer-reviewed journals), create posters and give presentations at conferences. Over the past four years, out of fewer than 30 NSE participants, 15 are pursuing graduate school in science, three have earned their way into Phi Beta Kappa, two have won competitive graduate scholarships, and three are K-12 teachers. (ARC)

► **Antarctic Temperature Changes, 1958-2002:** For the first time since the International Geophysical Year in 1957, scientists have made a realistic estimate of a half-century of trends in Antarctic climate, based on measurements of surface temperatures and advanced statistical techniques. Antarctic temperature changes have potentially major consequences for the global system. Yet scientists' ability to map those changes has been limited, due to the large area and the highly heterogeneous network of surface stations in Antarctica. That fact, in turn, has led to a confusing mix of results reported to the public.



Gridded linear trends (degrees Centigrade/decade) of annual surface air temperatures for the period from 1958 to 2002. The white area indicates no observations. *Credit*: *John Walsh, Univ. of Alaska.*

Now, however, utilizing temperature data from 21 manned observing sites and 73 automated weather stations, together with cooperative ship reports from the surrounding oceans, the NSF-supported investigators produced a high-quality trend assessment.

The results show that the most prominent trend in annual surface air temperature for 1958-2002 is the significant warming over the Antarctic Peninsula. Other characteristics are a slight warming in coastal Antarctica, and actual cooling over regions of central Antarctica and parts of the Southern Ocean. The Antarctic Peninsula warming is strongest in autumn and winter, but is apparent in all seasons. Results of the research are available at http://igloo.atmos.uiuc.edu/ANTARCTIC/ (ANT)

► **The Importance of Fungi-Plant Symbiosis:** A new technique that was originally developed to understand Arctic mushrooms has begun to shed light on ecosystems around the world — and could have application to improved farming practices.

The research began with the well-known symbiosis between mushrooms and other soil fungi, and certain plants. When the nitrogen is scarce, the fungi will transport the vital nutrient from the soil to the plant roots, and receive plant sugars in return. The challenge for scientists is to measure this process.

To meet this challenge, John E. Hobbie and Erik A Hobbie, working at the NSF-funded Arctic Long Term Ecosystem Research site at Toolik Lake, Alaska, developed a new method based on the measurement of nitrogen isotopes. Using it, they found that 61-86 percent of the nitrogen in the plants is provided by the fungi, and 8-17 percent of the plants' photosynthetic carbon is provided to the fungi for growth and respiration.

Because this kind of fungi-plant relationship is quite widespread in nature — and because nitrogen scarcity is quite common — this approach should help interpret ecological observations at many other research sites, and could even have application to agriculture. (ARC)

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 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Senior Researchers	786	860	900
Other Professionals	668	740	780
Postdoctorates	123	140	150
Graduate Students	356	390	410
Undergraduate Students	237	260	280
Total Number of People	2,170	2,390	2,520

NOTE: FY 2007-8 estimates are based on the expected impact of IPY on OPP's funding profile.

OPP Funding Profile

	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Statistics for Competitive Awards:			
Number	240	300	325
Funding Rate	31%	35%	37%
Statistics for Research Grants:			
Number of Research Grants	193	250	300
Funding Rate	27%	31%	33%
Median Annualized Award Size	$132,234	$136,200	$143,000
Average Annualized Award Size	$150,488	$155,000	$162,700
Average Award Duration, in years	2.7	3.0	3.0

NOTE: FY 2007-8 estimates are based on the expected impact of IPY on OPP's funding profile.

Arctic Sciences $96,270,000

The FY 2008 Budget Request for Arctic Sciences (ARC) is $96.27 million, an increase of $6.68 million, or 7.5 percent, over the FY 2007 Request of $89.59 million.

Arctic Sciences Funding

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Arctic Sciences (ARC)	**$74.21**	**$89.59**	**$96.27**	**$6.68**	**7.5%**
Major Components:					
Research & Education Projects	43.06	44.69	52.67	7.98	17.9%
Facilities					
Research Support & Logistics	31.15	44.90	43.60	-1.30	-2.9%

Totals may not add due to rounding.

About Arctic Sciences:

In the 1990's, global atmospheric models began to converge in their predictions that the Arctic would be at the forefront of global climate change. It now appears that those models were reasonably accurate in that regard. Observations have revealed an estimated 14% per decade reduction in summer sea ice extent in the Arctic, and significant summer melting of the Greenland Ice Sheet. These and many other phenomena are forcing change and uncertainty in traditional Arctic populations, present challenges and opportunities for industry and commerce, and have the potential to affect the global population through changes in sea level.

Arctic Sciences (ARC) is organized into several programs that support social science, earth system science and a broad range of natural science. Educational projects are also supported. Beginning in 1999, OPP established a Research Support and Logistics program to assist researchers with access to the Arctic, improve safety and environmental stewardship, and increase the ability of researchers to share plans and results with local Arctic communities.

The goal of the Arctic Sciences Division is to gain a better understanding of the Earth's physical, biological, geological, chemical, social, and cultural processes, and the interactions of ocean, land, atmosphere, biological, and human systems in the Arctic. ARC and other NSF programs support projects that contribute to the development of the next-generation of researchers and scientific literacy for all ages through education, outreach, and broadening participation in science, technology, engineering and mathematics. Program representatives from OPP and other NSF programs that support arctic research coordinate across NSF, including joint review and funding of arctic proposals and mutual support of special projects with high logistical costs.

In general, 59% of the ARC portfolio is available for new research grants. The remaining 41% funds continuing grants made in previous years, and research support and logistics.

Arctic Sciences Priorities for FY 2008:

- **Understanding Environmental Change in the Arctic —** Increase the use of modeling and synthesis to determine the nature and extent of current Arctic-system scale changes and the role of these changes as part of the global system.
- **Arctic Observing Network —** Continue to enhance an internationally supported, sustainable network to provide critical observations of the Arctic environment and use cyberinfrastructure tools to form a true network from the existing group of sites.
- **Bering Sea Ecosystem Study —** The eastern Bering Sea supports highly productive marine ecosystems that annually generate roughly 50% of all fish and shellfish landings in the United States. Models and observations suggest that the ecosystem will experience change. The Bering Sea Ecosystem Study is designed to develop an understanding of the effects of a varying sea-ice cover on the shelf ecosystem, project the potential changes in response to anticipated climate variations on decadal time scales, and assess the vulnerability and sustainability of local communities to such changes.
- **Human Systems in Polar Regions —** Humans have been an integral part of the arctic polar environment for the last 10,000 or more years. Indigenous peoples as well as recent migrants into the region have influenced and been influenced by the natural environment. IPY will encourage studies that advance the understanding of our species' place in the complex system of polar phenomena.
- **Improve research infrastructure —** Improve year-round access, capacity, and effectiveness of research sites in Alaska and throughout the Arctic.

Changes from FY 2007:

- $2.0 million moves from IPY logistics to IPY research, as logistics are fully funded in FY 2007.
- An increase of $5.70 million to accelerate climate change research using both modeling and observational systems including the human aspects of the change.
- An increase of $0.70 million to improve year-round capacity and effectiveness at NSF-supported field stations in the Arctic.
- An increase of $0.28 million to support additional integration of education with research during IPY.

Antarctic Sciences $64,490,000

The FY 2008 Budget Request for Antarctic Sciences (ANT) is $64.49 million, an increase of $7.51 million, or 13.2 percent, over the FY 2007 Request of $56.98 million.

Antarctic Sciences Funding

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Antarctic Sciences (ANT)	**$48.21**	**$56.98**	**$64.49**	**$7.51**	**13.2%**
Major Components:					
Research & Education Projects	44.26	52.53	60.04	7.51	14.3%
Centers Programs					
STC: Center for Remote Sensing of Ice Sheets	3.95	4.45	4.45	-	-

Totals may not add due to rounding.

About Antarctic Sciences:

The Antarctic continent and the Southern Ocean constitute about 7% of the surface of Earth and are important components of the Earth system. The continent contains records of geological processes that reveal the role of the Antarctic in the long-term evolution of the planet including records of the evolution of life on Earth. The region hosts organisms and ecosystems that have evolved and adapted to survive and thrive in extreme cold and long periods of darkness. The ice sheets hold detailed records of past climatic conditions, including direct samples of the atmosphere, that reach back 800,000 years, and perhaps more. The annual formation and breakup of sea ice around the continent is a major phenomenon that drives ocean circulation and has a major impact on Earth's heat budget. The ice sheets, surrounding ocean, and atmosphere are also key systems that must be understood in order to advance our understanding of sea level change and its role in climate change. In addition to these aspects of understanding the Antarctic and its role in Earth processes, the high plateau of East Antarctica, and South Pole Station in particular, are unrivaled with respect to the conditions they offer for a wide array of astronomy and astrophysical research.

The goal of Antarctic Sciences (ANT) is to enable research in all areas of science that can only be done, or is best done, in Antarctica. This is done through funding disciplinary and cross-disciplinary programs that encompass the geosciences, biosciences, and physical sciences. ANT enables research on Earth's physical, biological, geological, glaciological, oceanographic, and atmospheric processes in Antarctica as well as on interactions between the ice sheets, the underlying continent, the surrounding ocean, and the overlying atmosphere toward a comprehensive understanding of Antarctica's role in the evolution of Earth and life on Earth, as well as the Antarctic environment's role in the whole Earth system. In particular, a new programmatic emphasis will foster linkages across the disciplines in order to better advance understanding of Antarctic climate as a system. ANT also enables research in astronomy and astrophysics to advance understanding about high energy phenomena such as supernovae and events associated with black holes, about the nature of dark energy and dark matter which is now known to be a major component of the universe, as well as advance general understanding about the origin and evolution of the universe.

In general, 32% of the ANT portfolio is available for new research grants. The remaining 68% is used primarily to fund continuing grants made in previous years.

Antarctic Sciences Priorities for FY 2008:

- **International Polar Year (IPY) -** Building on partnerships developed during the early stages of IPY, Antarctic Sciences has the following priorities:
  - **East Antarctic Ice Sheet and lithosphere system —** The goal is to achieve a basic understanding of both the ice sheet and underlying lithosphere in central East Antarctica, as well as an understanding of the major processes and interactions that control ice sheet change.
  - **Life in the polar night —** The goal is to advance understanding of seasonal environmental change during the transitions between relative warmth and abundant light of summer and the extreme cold and dark of winter, and to advance knowledge about how organisms and ecosystems have adapted and evolved to survive and thrive.
  - **Paleoclimate records from central West Antarctica —** The goal is to exploit the deep ice core recovered from the WAIS-Divide site for climate records that can be compared to the Greenland Ice Core record to advance understanding of polar climate change, particularly the processes and timing of abrupt climate change.
- **Astronomy and Astrophysics** – Increase the research exploitation phase for two major new discovery instruments that are expected to begin science operations in 2007 – the IceCube Neutrino Observatory and the 10m South Pole Telescope. These two projects are expected to enable discovery of new phenomena and to achieve understanding about the origin and evolution of the universe.

Changes from FY 2007:

- **Remote Sensing Instrumentation –** an increase of $2.0 million to support development of instrumentation and equipment required for critical observations in all areas of Antarctic science.
- **IceCube Neutrino Observatory –** an increase of $2.79 million to enable early science operations ($1.50 million) for the part of the detector array that has been completed (estimated to be 20 of 70 detector strings) and research ($1.29 million) to exploit data returned from the growing array. This represents ANT's contribution to joint funding for IceCube science operations and research with the Division of Physics within the Directorate for Mathematical and Physical Sciences.
- **International Polar Year –** an increase of $2.72 million to the core programs to support the U.S. leadership role in IPY. Anticipated emphasis will be on ice sheet studies, East Antarctic lithosphere, and Antarctic systems.

Antarctic Infrastructure & Logistics $240,660,000

The FY 2008 Budget Request for Antarctic Infrastructure & Logistics (AIL) is $240.66 million, an increase of $12.05 million, or 5.3 percent, over the FY 2007 Request of $228.61 million.

Antarctic Infrastructure & Logistics Funding

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Antarctic Infrastructure & Logistics (AIL)	**$203.17**	**$228.61**	**$240.66**	**$12.05**	**5.3%**
Major Components:					
Facilities					
Operations & Science Support	136.51	161.09	173.14	12.05	7.5%
U.S. Antarctic Logistical Support Activities	66.66	67.52	67.52	-	-

Totals may not add due to rounding.

About Antarctic Infrastructure & Logistics:

Operations & Science Support

Antarctic Infrastructure & Logistics (AIL) supports the science community through a network of stations, laboratories, equipment, and logistical capabilities that enable research activities in Antarctica. This includes operation of a year-round inland research station at the South Pole (90° south latitude); two year-round coastal research stations (McMurdo at 78°S and Palmer at 64°S) with extensive laboratory, transportation, housing, communication, and computing capabilities; summer camps (as required for research); icebreaking research ships--the *Laurence M. Gould* and the *Nathaniel B. Palmer*; a fleet of ski-equipped LC-130 airplanes operated and maintained by the Air National Guard; U.S. Air Force inter-continental transport; small fixed winged aircraft and helicopters; and icebreakers for channel breaking at McMurdo Station.

AIL uses a mix of government and civilian contract service providers to conduct oversight and research support activities in Antarctica. The largest of these contracts is an operations and maintenance contract with Raytheon Polar Services Company of Centennial, Colorado.

Back-up Icebreakers. Since 2004, AIL has contracted with civilian operators to provide back-up icebreaking support to the U.S. Coast Guard due to heavy ice conditions in the McMurdo Sound region and maintenance issues with the USCG polar icebreakers. During FY 2005 and 2006, AIL contracted with FESCO, a Russian company, for the icebreaker *Krasin*. During FY 2007, AIL was able to contract for the services of the Swedish research icebreaker *Oden*. Ice conditions in the McMurdo Sound region appear to be returning to “normal”. The USCG, however, continues to recommend that back-up icebreakers be available. This recommendation, together with continuing concerns over the reliability of the USCG Polar Class icebreakers, makes it prudent to plan to continue to secure back-up icebreaking services in FY 2008. This cost is in addition to the cost of “United States Coast Guard Polar Icebreaking” discussed later.

U.S. Antarctic Logistical Support Activities

The U.S. Antarctic Logistical Support Activities budget line funds support provided by the U.S. Department of Defense. The DoD operates as a primary logistical support provider on a cost-reimbursable basis. Major funding elements of DoD support include: military personnel, LC-130 flight operations, maintenance, and facilities support of the 109th Airlift Wing (AW) of the New York Air National Guard in Scotia, New York and Antarctica; transportation and training of military personnel supporting the U.S. Antarctic Program; 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; bulk fuel purchased from the Defense Logistics Agency; and reimbursement for use of Department of Defense satellites for communications.

Antarctic Infrastructure & Logistics Priorities for FY 2008:

- A major focus for AIL in FY 2008 is support of IPY activities. This includes extensive field efforts in West Antarctica for studies of Ice Sheet Dynamics and extending the science support operating season at McMurdo station and the Dry Valleys for studies of Life in the Cold and Dark.
- The ability to resupply McMurdo and South Pole stations will be diversified and strengthened as the fuel storage capacity at McMurdo station is increased and the surface traverse to South Pole becomes operational.
- Two additional major capital infrastructure projects include increasing the high bandwidth communication capability at the South Pole to support the 10m South Pole Telescope and IceCube, and the first phase of construction to replace the pier at Palmer Station which is critical to allow resupply ships to dock at the station.

Changes from FY 2007:

- An increase of $6.10 million to continue the procurement and construction of additional fuel tanks for McMurdo Station;
- An increase of $6.78 million to study and implement alternative methods of resupplying South Pole Station via air and ground;
- An increase of $2.17 million for continued design, engineering studies, and advance procurements to support the replacement of the Palmer Station Pier;
- An increase of $2.0 million to enhance the power generation capability and fuel storage at South Pole Station to support new science projects;
- An increase of $1.0 million to begin replacement of legacy software systems which have become unsupportable and are incompatible with current requirements to safeguard data and personal information;
- $2.0 million to deliver and install the final components of the South Pole Telescope is funded by deferring the Williams Field Runway Relocation project; and
- A decrease of $3.0 million for complete and near-complete projects (SHALDRIL project is ending, and there will be cost reductions in the Microwave Landing System and McMurdo Bandwidth projects) and $3.0 million from IPY logistics.

Polar Environment, Safety & Health $6,480,000

The FY 2008 Budget Request for the Polar Environment, Safety & Health (PESH) is $6.48 million, an increase of $56,000 thousand, or 9.5 percent, over the FY 2007 Request of $5.92 million.

Polar Environment, Safety & Health Funding

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Polar Environment, Safety & Health (PESH)	**$5.01**	**$5.92**	**$6.48**	**$0.56**	**9.5%**

About Polar Environment, Safety & Health:

Established in December 2005, the Polar Environment, Safety & Health (PESH) Office within OPP manages and oversees the environmental, safety, and health aspects of research and operations conducted in polar regions. PESH 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 and of OPP-sponsored activities in polar regions. PESH also ensures compliance with environmental, safety, and health related regulatory, statutory, and international treaty requirements.

Polar Environment, Safety & Health Priorities for FY 2008:

In FY 2008, PESH will focus on reviewing, updating, and completing a USAP Safety Manual; revising the USAP Medical Screening Guidelines to reflect advances in on-ice diagnostic and treatment capabilities and in medical science. Continuing attention will be paid to identifying and addressing health and safety risk factors responsible for illnesses and injuries in the polar regions.

Changes from FY 2007:

- An increase of $56,000 thousand for safety and health measures in remote field research and program oversight, for updating USAP medical screening guidelines, and for additional health and safety measures to support IPY “winter science.”

United States Coast Guard Polar Icebreaking $57,000,000

The FY 2008 Budget Request for United States Coast Guard (USCG) Polar Icebreaking is $57.0 million, equal to the FY 2007 Request of $57.0 million.

USCG Polar Icebreaking Funding

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
USCG Polar Icebreaking	**$59.94**	**$57.00**	**$57.00**	**-**	**-**

About U.S. Coast Guard Polar Icebreaking:

Since FY 2006, NSF has been responsible for funding the USCG's three polar icebreakers. The agencies cooperate under a Memorandum of Agreement that includes guidance for planning and scheduling. It sets forth the terms and conditions for reimbursement to the USCG from NSF. NSF and the USCG work together to formulate operations and maintenance plans and associated funding requirements. NSF is responsible for ascertaining the needs of other federal agencies and for securing USCG program plans for accommodating them, on a reimbursable funding basis.

NSF will shortly convene an external expert review of the USCG's requests for maintenance funding for the *Polar Star* and *Polar Sea*, and the *Healy*. Thus, while costs in FY 2008 are currently expected to remain the same as in FY 2007, there is the possibility that the review may validate a requirement to perform more or less maintenance on the ships pending a national policy determination.

This USCG icebreaking cost is in addition to the cost of back-up icebreakers discussed in "Antarctic Infrastructure & Logistics."

INTEGRATIVE ACTIVITIES $263,000,000

The FY 2008 Budget Request for Integrative Activities (IA) is $263.0 million, an increase of $31.63 million, or 13.7 percent, above the FY 2007 Request of $231.37 million. The Experimental Program to Stimulate Competitive Research (EPSCoR) has been transferred from Education and Human Resources to Integrative Activities. This move places EPSCoR within the NSF Office of the Director in order to maximize cross-directorate interaction and to ensure continued integration with the research and education directorates.

Integrative Activities Funding[1]
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Integrative Activities	$233.30	$231.37	$263.00	$31.63	13.7%

[1]Includes funding for EPSCoR for all years shown for comparability. EPSCoR has been transferred from Education and Human Resources to Integrative Activities.

RELEVANCE

Integrative Activities supports emerging, cross-disciplinary research and education, recognizing the importance 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. Also supported are a number of integrative research and education centers and programs that 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 funds 17 centers that are managed cooperatively by six NSF directorates/offices and the Office of Integrative Activities.

Another example is EPSCoR. In FY 2006 NSF leadership requested a workshop addressing the future of the EPSCoR Program. As a result of that workshop a report was prepared and submitted: *EPSCoR 2020: Expanding State Participation in Research in the 21ST Century – A New Vision for the Experimental Program to Stimulate Competitive Research (EPSCoR).* One of the main issues arising from the workshop was the need to find a mechanism within NSF that would ensure that EPSCoR goals are integrated into the performance of all NSF directorates. The report went on to state that "EPSCoR should be relocated within the Office of the Director where its 'research' focus and cross-directorate interactions will be maximized and integrated with the Research Directorates." Thus, funding for EPSCoR is moved from the Directorate for Education and Human Resources to IA within the Office of the Director. IA is able to coordinate and manage efforts throughout the Foundation. The relocation will allow the EPSCoR program greater leverage for improving the research infrastructure, planning complex research agendas, and developing scientific and engineering talent for the 21st century.

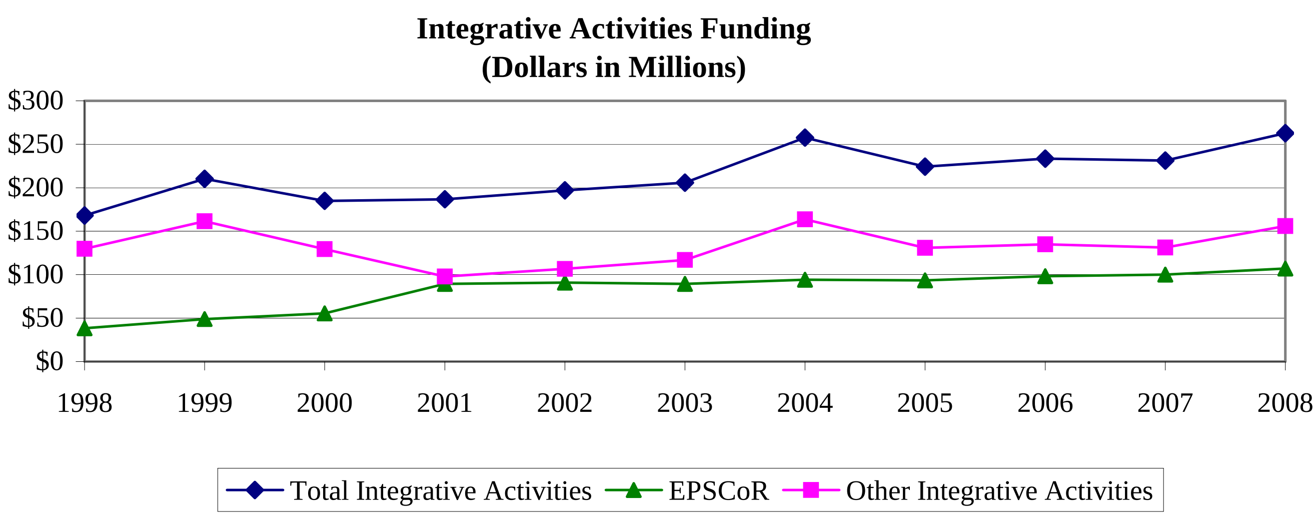
Integrative Activities Funding by Program

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	FY 2007 Request Amount	FY 2007 Request Percent
EPSCoR[1]	$98.22	$100.00	$107.00	$7.00	7.0%
Major Research Instrumentation	88.39	90.00	114.44	24.44	27.2%
Partnerships for Innovation	9.34	9.19	9.19	-	-
Science and Technology Centers	12.41	0.90	0.90	-	-
Science and Technology Policy Institute/RaDiUS	4.28	4.28	4.47	0.19	4.4%
Science of Learning Centers	20.66	27.00	27.00	-	-
Total, Integrative Activities	$233.30	$231.37	$263.00	$31.63	13.7%

Totals may not add due to rounding.

[1] Includes funding for EPSCoR for all years shown for comparability. EPSCoR has been transferred from Education and Human Resources to Integrated Activities.



Summary of Major Changes in Agency-Wide Investments ***(Dollars in Millions)***

FY 2007 Request, IA..$231.37

<u>Discovery Research for Innovation</u>

Experimental Program to Stimulate Competitive Research +$7.00

EPSCoR has been transferred from Education and Human Resources to IA. The FY 2008 Budget Request for EPSCoR is $107.0 million, an increase of $7.0 million, or 7.0 percent, over the FY 2007 Request of $100.0 million. The increase will be used to co-fund research and education proposals that are merit reviewed throughout NSF and that are submitted by eligible institutions within EPSCoR jurisdictions.

Transformational Facilities and Infrastructure

Major Research Instrumentation (MRI) +$24.44

With an increase of $24.44 million, or 27.2 percent, over the FY 2007 Request of $90.00 million, funding for MRI is $114.44 million for FY 2008. This growth allows the MRI program to initiate greater support for acquisition and development of mid-size instruments as recommended in the recent National Academy of Sciences Report on Advanced Research Instrumentation and Facilities. During FY 2008 the MRI funding cap will rise from $2.0 million to $4.0 million for single instrument requests submitted by eligible institutions. Examples in this mid-size range include: biological imaging instruments; 3-D shake tables; e-beam lithography and nanofabrication tools; large scale environmental monitoring instruments; proteomics facilities; spectroscopy instruments; beam line development; detectors for use at accelerator labs; large scale petawatt lasers; larger computing systems; and ocean observatories.

Science and Technology Policy Institute/RaDiUS +$0.19

The NSF's FY 2008 Budget Request provides $3.04 million for the Science and Technology Policy Institute (STPI) and $1.43 million for the Research and Development in the United States (RaDiUS) database for a total request of $4.47 million for FY 2008. This represents a 4.4 percent increase over the FY 2007 Request of $4.28 million. The increase ensures the collection, access, and archiving of information on federal funding for research and development as well as support for science and technology policy formation by the Office of Science and Technology Policy (OSTP).

Subtotal, Changes +$31.63

FY 2008 Request, IA....……………………..…………..……………………………....…….$263.00

IA Portfolio Updates

EPSCoR

Please see two-page narrative below.

Major Research Instrumentation

MRI is a Foundation-wide, cross-cutting initiative that supports the acquisition and development of instrumentation relating to several goals and objectives of the American Competitiveness Initiative (ACI), including nanotechnology, computing, physical sciences, and materials science and engineering. Funding provides for a diverse portfolio that emphasizes state-of-the-art instrumentation, access and training to support modern research approaches, cross-disciplinary research, integration of research and education, public/private partnerships, and assistance to minority-serving institutions. Funding also provides for acquisition and development of state-of-the-art instrumentation that is too costly to be supported through regular NSF programs. It promotes partnerships between academic researchers and private sector instrument developers. Approximately $20.0 million support teaching-intensive and minority-serving institutions, including Historically Black Colleges and Universities, Tribal Colleges, and community colleges, with a focus on research training.

In the FY 2006 MRI competition, NSF received 769 proposals and funded 235 for a total of $88.39 million. Minority-serving institutions received 24 awards totaling $4.82 million. Non-Ph.D. granting institutions received 92 awards totaling $19.48 million. At the FY 2008 Request level, approximately 241 competitive awards are anticipated.

Partnerships for Innovation (PFI)
PFI program links knowledge created in the discovery process to learning and innovation. Goals are to: (1) stimulate knowledge transformation created by the national research and education enterprise into innovations that create new wealth; build strong economies; and improve the national well-being; (2) broaden participation to more fully meet the broad workforce needs of the national innovation enterprise; and (3) enhance enabling infrastructure necessary to foster and sustain innovation in the long-term. In these ways, the PFI program directly addresses the key objectives of the ACI; namely, introducing valuable techniques to the marketplace. Partnerships must include a U.S. academic institution as the lead and a partner from the private sector; state/local government partnerships are also encouraged. At a flat funding level of $9.19 million, 10 to 15 awards are expected in FY 2008.

Science of Learning Centers (SLC)
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. 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 2008 funds provide continuing support for the portfolio of six Centers as well as support the development of infrastructure and activities to maximize coordination and exchange of information among all SLCs.

Science and Technology Policy Institute/RaDiUS
STPI is a Federally-Funded Research and Development Center established by Congress in 1991 to support the complex task of devising and implementing science and technology policy. The Institute provides analytic support to OSTP to identify near-term and long-term objectives for research and development and options for achieving those objectives. In addition, STPI provides analytic support to other federal agencies. Since 2003, the Institute for Defenses Analyses has operated the Institute. RaDiUS is a database developed by the RAND Corporation to support the work of OSTP. Since its inception, the database has been maintained by the RAND Corporation in cooperation with NSF.

Science and Technology Centers (STCs)
The STC Program advances discovery and innovation in science and engineering through the integration of cutting-edge research, excellence in education, targeted knowledge transfer, and development of a diverse workforce while broadly advancing the goals and objectives of the ACI. The STC portfolio includes continuing investment in areas from cyber-security, materials and devices for information technology research, and embedded networked sensing to nanobiotechnology, behavioral neuroscience, and multi-scale modeling of atmospheric processes. Partnerships established by the STC program go beyond NSF and academia to the active participation of industry and national laboratories in research projects, the transfer of technology to appropriate industries, the application of patents derived from the work of the STCs, and the launching of spin-off companies. The number of STCs currently supported (17) is expected to remain the same in FY 2008.

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 (COVs), 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 supported through the use of a competitive, merit-based process. To ensure the highest quality in processing and recommending proposals, NSF convenes COVs, composed of qualified external evaluators, to review each program. These experts assess the integrity and efficiency of proposal review processes and provide a retrospective assessment of the quality of results of NSF's investments. Several programs conduct annual reviews and undergo reviews and assessments of program outcomes.

Activities such as the STC program maintain 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.

Another example is found in the MRI program, a Foundation-wide cross-cutting activity. MRI 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 reviews, the program conducts an overall evaluation. In FY 2005, the MRI program convened a COV during which external evaluators examined overall program management and processes, proposal actions, and results of NSF investments from FY 2000 to FY 2004. The COV commended the program for enhancing the research capacity of the science and engineering community.

As for EPSCoR, in FY 2006 a workshop was held to envision the program in the year 2020. The report provided recommendations on how to move EPSCoR to the next level of quality and performance through its continuing programmatic focus on accomplishments and improvement. A COV or an external program evaluation will be planned in FY 2007 and implemented in FY 2008 for the purpose of assessing the EPSCoR award portfolio, studying and reporting on the management of the EPSCoR activities, and assessing the research and education outcomes.

EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH $107,000,000

The FY 2008 Budget Request for the Experimental Program to Stimulate Competitive Research (EPSCoR) is $107.0 million, an increase of $7.0 million, or 7.0 percent, over the FY 2007 Request of $100.00 million. EPSCoR has been transferred from Education and Human Resources to Integrative Activities. This move places EPSCoR within the NSF Office of the Director in order to maximize cross-directorate interaction and to ensure continued integration with the research and education directorates.

Experimental Program to Stimulate Competitive Research Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
EPSCoR Funding	$98.22	$100.00	$107.00	$7.00	7.0%

About EPSCoR:

EPSCoR's mission is to assist 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 – Alabama, Alaska, Arkansas, Delaware, Hawaii, Idaho, Kansas, Kentucky, Louisiana, Maine, Mississippi, Montana, Nebraska, Nevada, New Hampshire, New Mexico, North Dakota, Oklahoma, Rhode Island, South Carolina, South Dakota, Tennessee, Vermont, West Virginia, and Wyoming – plus the Commonwealth of Puerto Rico and the Territory of the Virgin Islands

EPSCoR goals and objectives are strongly aligned with major actions recommended recently by the National Academies’ Committee on Prospering in the Global Economy of the 21st Century. That is, programmatic objectives are designed to stimulate further scientific and engineering prowess in the 27 EPSCoR jurisdictions. These jurisdictions have significant unused potential for contributing to the Nation’s technological-based discovery, innovation, and related competitive productivity.

The EPSCoR portfolio includes support for infrastructure development, instrumentation, workforce development, and research grants. Approximately 51 percent is available for new awards each year while approximately 30 percent of the EPSCoR portfolio is available for new research grants. The remainder is distributed for various EPSCoR priorities and continuing funding for grants made in previous years.

EPSCoR Priorities for FY 2008:

To pursue its goals and objectives during FY 2008, the EPSCoR program will employ a portfolio of four complementary investment strategies:

Research Infrastructure Improvement (RII) Grants – Research Infrastructure Improvement Grants are 36 to 48 month awards of up to $9.0 million to support infrastructure improvements in research areas selected by the jurisdiction's EPSCoR governing committee as having the best potential to improve future research and development competitiveness. Successful awards will build the core strength and capacity needed to develop collaborative methods for the solution of research and education problems of both regional and national import.

Strength-Based Research Collaborative (SBRC) Grants **–** SBRC awards are 48 month awards of up to $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 use 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 research and education proposals submitted directly to the research and education directorates and offices of the NSF. Co-funding is an internal NSF mechanism that allows the EPSCoR program to support cutting-edge research and education projects that have competed successfully through the merit review process within the regular NSF programs and initiatives. This mechanism allows the EPSCoR program to continue to build capacity in EPSCoR jurisdictions at the research frontier.

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 through "in-reach" activities with the research and development resources and potential residing within EPSCoR jurisdictions.

Changes from FY 2007:

In FY 2008, the EPSCoR program expects to provide $61.0 million to fund a combination of new and continuing RII awards. In addition, the program plans to fund two SBRC awards for a total of $6.0 million. Hence, the RII/SBRC will require a total of $67.0 million, which represents no change from the FY 2007 Request. Co-funding of proposals submitted from EPSCoR jurisdictions to other research and educational programs at NSF will be funded at $36.0 million, or a $7.0 million increase over the FY 2007 Request. This will take advantage of increased cyberinfrastructure opportunities to improve research and education networks within the EPSCoR community. EPSCoR co-funding of Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) proposals will be supported at $2.7 million, or no increase over the FY 2007 Request. About $1.3 million will be used to support outreach/inreach activities, workshops, conferences, and office operational functions. Support for co-funding, new SBIR/STTR projects, outreach, and other activities is similar to the FY 2007 Request level.

Number of People Involved in EPSCoR Activities

	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Senior Researchers	517	525	570
Other Professionals	222	225	255
Postdoctorates	69	70	75
Graduate Students	435	440	480
Undergraduate Students	378	380	420
Total Number of People	1,621	1,640	1,800

PERFORMANCE

The FY 2008 Budget Request is aligned to reflect funding levels associated with NSF's four strategic outcome goals stated in the FY 2006-2011 Strategic Plan. These goals provide an overarching framework for progress in fundamental research and education and facilitate budget and performance integration.

Integrative Activities
By Strategic Outcome Goal
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Discovery[1]	$130.45	$127.55	$134.14	$6.59	5.2%
Learning	9.34	9.19	9.19	-	-
Research Infrastructure	92.67	94.28	118.91	24.63	26.1%
Stewardship	0.84	0.35	0.76	0.41	117.1%
Total, IA	$233.30	$231.37	$263.00	$31.63	13.7%

Totals may not add due to rounding.

[1]Includes funding for EPSCoR for all years shown for comparability. EPSCoR has been transferred from Education and Human Resources to Integrative Activities.

Recent Research Highlights

► **Center for Remote Sensing of Ice Sheets:** A group of NSF-supported researchers at the Center for Remote Sensing of Ice Sheets (CReSIS) are developing new sensors, platforms, and cyberinfrastructure tools that will lead to a better understanding of Antarctic and Greenland ice sheets and how they contribute to sea level change. Because of the immense size and complexity of these ice sheets, data from satellite and airborne platforms, combined with ground-based measurements and observations, are needed to accurately assess them. One of the new radar-based sensors can produce a high-resolution map of layers within the ice, and has produced the first image of 3 kilometer thick ice. The technological innovations will provide long-term benefits to the polar community and also have wide applications outside of the polar community.

Collecting data in Greenland. *Credit: CReSIS, University of Kansas.*

The tools being developed under CReSIS will lead to a better understanding of polar ice sheets and how they contribute to sea level change. Because of the immense size and complexity of these ice sheets, data from satellite and airborne platforms, combined with ground-based, in-situ measurements and observations, are needed to accurately assess their mass balance state. Technological innovations are being made in three areas, including sensors, platforms, and cyberinfrastructure.

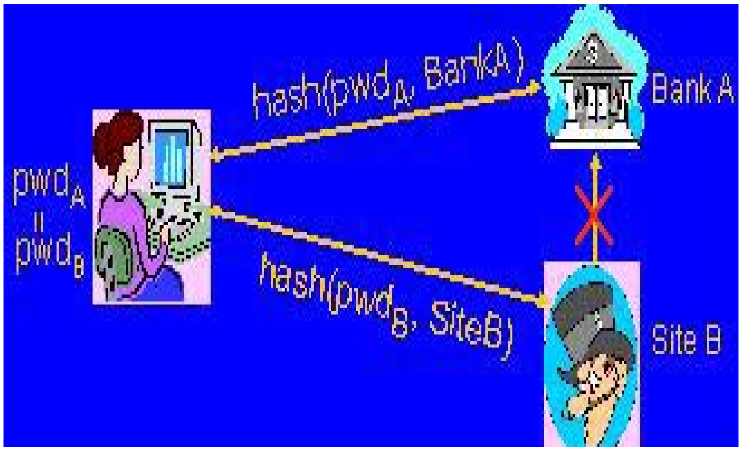
The next generation of researchers should reflect the diversity of our society. To this end, the Center is working closely with two minority-serving institutions, Haskell Indian Nations University in Lawrence, Kansas, and Elizabeth City State University in Elizabeth City, North Carolina. The Center is conducting extensive outreach and education programs to attract minority students to careers in science and technology. (OPP/STC)

► **New Organic Electronic Materials and Devices:** The Center on Materials and Devices for Information Technology Research (CMDITR), which is researching novel light sources and organic electronics, has developed highly efficient organic solar-energy cells that perform extremely well with visible light. These new devices have the potential to provide lower-cost replacements to traditional crystalline silicon-based solar energy cells. These replacements, in turn, could provide new portable and clean power solutions for technologies such as wireless sensor networks.

A sample of an organic solar cell fabricated on a flexible plastic substrate. An array of conventional silicon solar cells is shown in the background. *Credit: Nicole Cappello, Georgia Tech.*

CMDITR, under the leadership of the University of Washington, fosters innovative partnerships that integrate multiple academic institutions from different regions of the country with a wide-range of non-academic institutions to examine novel uses of materials and devices leading to the development of new technologies. (MPS/STC).

► **Team for Research in Ubiquitous Secure Technologies (TRUST) - Password Hashing:** Computer scientists at Stanford University have developed a new tool called Password Hash (PwdHash) that adds additional security to Internet browsers. The PwdHash tool is a user-installed, transparent add-on that stops "phishing" attacks – malicious attempts to obtain personal information such as account numbers or passwords.



The PwdHash browser extension transparently produces a cryptographically customized password for each site, defeating phishing. See also the Spoof Guard tool at http://crypto.stanford.edu/SpoofGuard/. *Credit: Dan Boneh and John Mitchell.*

In phishing attacks, a user is sent a deceptive email explaining that the recipient has an account problem and should visit their financial site and log in. However, the link provided in the phishing email sends the user to a "spoof" site that exists solely to collect the user's information. Once the personal information is collected, criminals may subsequently log into the user's real account to steal assets or cause other damage. The PwdHash tool automatically converts a user's password into a new, domain-specific password by translating the contents of password fields into a mathematically generated number. The new number, called a "hash," cannot be translated back into the password. The easy-to-use PwdHash tool can be used at public computers and requires only the user – not the user and the bank – to use it.

The researchers have also developed a second browser extension called SpoofGuard, which warns users with a traffic light motif (green, yellow, red) when they are visiting suspected spoof sites. The extension does not transmit sensitive information until the user responds to the warning. (CISE/STC).

► **Solar Energy Efficiency Breakthrough Made Possible by State-of-the-Art Equipment:** Funded in part by NSF's Experimental Program to Stimulate Competitive Research (EPSCoR), a research team from New Mexico State University (NMSU) and Wake Forest University has brought a variety of futuristic solar-cell applications closer to reality. Examples include roofing paints that could provide enough alternative energy to heat and cool your home, or energy sources that soldiers could carry around like a roll of plastic wrap in their backpacks. The organic solar cells developed by this team are made of relatively inexpensive and flexible plastic that can be wrapped around structures or even applied by spin or spray coating, according to Seamus Curran, head of the NMSU nanotechnology laboratory and member of the research team. This puts them in sharp contrast to traditional solar panels made of silicon, which is expensive, brittle and shatters like glass. The new organic solar cells are also impressively efficient. To be effective producers of electricity, solar cells must be able to convert 10 percent of the energy in sunlight to electricity – a landmark many believed would take at least a decade to achieve. Yet Curran's research team recently achieved 5.2 percent solar energy efficiency with organic solar cells, and he predicts it may take fewer than five years before they reach the 10 percent level. (EPSCoR).

UNITED STATES ARCTIC RESEARCH COMMISSION $1,490,000

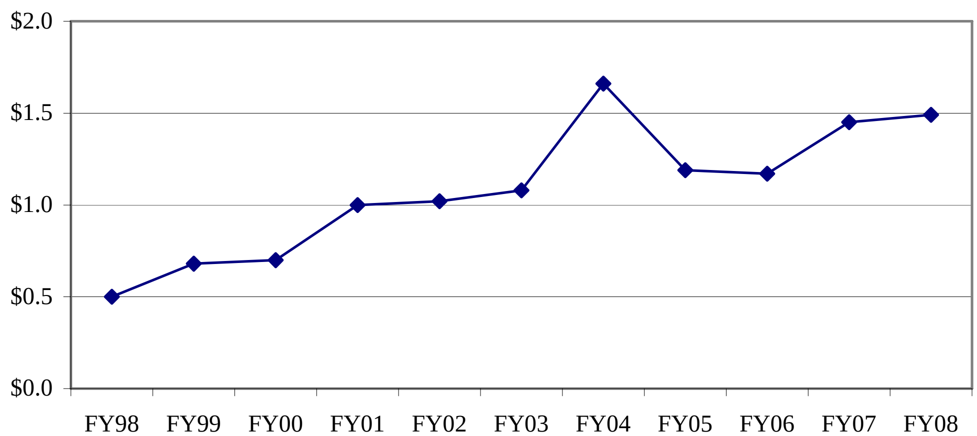
The FY 2008 Budget Request for the United States Arctic Research Commission (USARC) is $1.49 million, an increase of $40,000, or 2.8 percent, over the FY 2007 Request of $1.45 million.

United States Arctic Research Commission Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
United States Arctic Research Commission	$1.17	$1.45	$1.49	$0.04	2.8%

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, USARC 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. USARC 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. Special attention will also be placed on emphasizing Arctic scientific research during the "International Polar Year, 2007-2008."

United States Arctic Research Commission Funding
(Dollars in Millions)



Note: The increase in FY 2004 reflects a one-time recovery of $370,000.

USARC is an independent federal agency, historically funded through NSF's appropriations. In FY 2007, USARC was proposed as a separate activity within the Research and Related Activities (R&RA) appropriations account, and the proposal has been accepted, based on appropriations language to date. This addresses the recommendations of several audits of USARC, as well as the Commissioners and auditors concerns that the Commission was not dealt with as an independent agency when the budget was appropriated within the Office of Polar Programs (OPP) as in FY 2006 and prior years.

The United States Arctic Research Commission is requesting an increase of $40,000 above the FY 2007 Request. The added funding is for salaries – specifically increased funding for Commissioners salaries – as well as for travel and administrative costs. GSA's financial and accounting services to USARC have increased by 50% over the past two years, and USARC will incur costs to become compliant with federal directives, such as the "No FEAR Act" and Homeland Security Presidential Directive-12, among others.

EDUCATION AND HUMAN RESOURCES $750,600,000

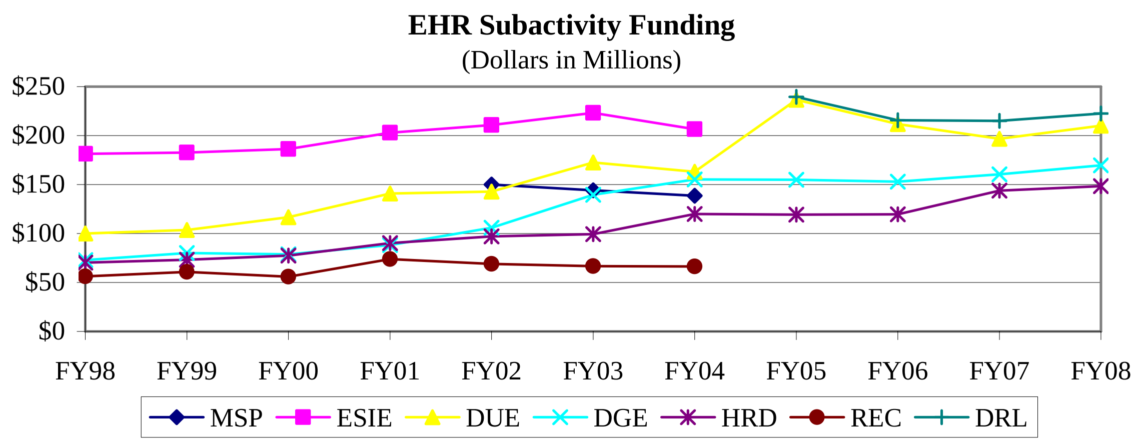
The FY 2008 Budget Request for the Directorate for Education and Human Resources (EHR) is $750.60 million, an increase of $34.38 million, or 4.8 percent, over the FY 2007 Request of $716.22 million. The presentation here reflects the transfer of EPSCoR from Education and Human Resources to Research and Related Activities.

Education and Human Resources Funding
(Dollars in Millions)

	FY 2006 Actual [1]	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Research on Learning in Formal and Informal Settings (DRL)	$215.58	$215.00	$222.50	$7.50	3.5%
Undergraduate Education (DUE)	211.86	196.80	210.22	13.42	6.8%
Graduate Education (DGE)	153.07	160.57	169.50	8.93	5.6%
Human Resource Development (HRD)	119.75	143.85	148.38	4.53	3.1%
Total, EHR [2]	$700.26	$716.22	$750.60	$34.38	4.8%

Totals may not add due to rounding.
[1] FY 2006 Actual reflects FY 2007 and FY 2008 structure of programs.
[2] Excludes funding for EPSCoR for all years shown for comparability. EPSCoR has been transferred from EHR to R&RA. Also excludes $99.40 million in FY 2006 obligations and an estimated $100.0 million in FY 2007 and FY 2008 receipts 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, to improve the health, prosperity, welfare, and security of the Nation, and to build the science, technology, engineering, and mathematics (STEM) workforce of the 21st century.



Beginning in FY 2005, data reflect the FY 2007 structure of programs and subactivities. At the subactivity level, ESIE and REC are combined to form DRL. MSP is merged into DUE.

The Experimental Program to Stimulate Competitive Research (EPSCoR) has been transferred to Integrative Activities (IA). Included in the FY 2008 Budget Request for IA is funding for EPSCoR. This places EPSCoR within the NSF Office of the Director to maximize cross-directorate interaction and to ensure continued integration with the research and education directorates. Additional information on EPSCoR can be found in the IA chapter of this Request.

EDUCATION AND HUMAN RESOURCES

Appropriation Language

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, $750,600,000, to remain available until September 30, 2009.

Education and Human Resources
FY 2008 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Rescission	Carryover/ Recoveries	Total Resources	EPSCoR	Expired	Adj. Total Resources	Obligations Incurred/Est.[1]
FY 2006 Appropriation	$807.00	-$10.31	$2.26	$798.95	-$98.22	-$0.34	$700.39	$700.26
FY 2007 Request	816.22	-	0.13	816.35	-100.00	-	716.35	716.35
FY 2008 Request	750.60	-	-	750.60	-	-	-	750.60
$ Change from FY 2007								$34.25
% Change from FY 2007								4.8%

Totals may not add due to rounding.

[1]The FY 2008 Request for R&RA includes $107.0 million for EPSCoR. Prior to FY 2008, EPSCoR was funded through the Education and Human Resources appropriation.

Adjustments to Base

In FY 2006 and FY 2007, $98.22 million and $100.0 million, respectively, are presented for EPSCoR in Integrative Activities within the R&RA appropriation.

Explanation of Carryover

Within the Education and Human Resources (EHR) appropriation, a total of $127,903 was carried forward into FY 2007 including $110,000 for funding of the Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring Program (PAESMEM). The PAESMEM proposal recommendations are currently awaiting OSTP (White House) approval.

RELEVANCE

EHR is the principal source of federal support for strengthening S&E education through education research and development (R&D). 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.

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 President's American Competitiveness Initiative (ACI), which states:

> "Education is the gateway to opportunity and the foundation of a knowledge-based, innovation-driven economy. For the U.S. to maintain its global economic leadership, we must ensure a continuous supply of highly trained mathematicians, scientists, engineers, technicians, and scientific support staff as well as a scientifically, technically, and numerically literate population."

EHR's programs work to attract and retain people in STEM fields, increasing the Nation's ability to compete for and retain highly-skilled American workers. This includes:
- promoting cooperation among academic institutions, industry, and government to share STEM resources and ensure critical skills needed by employers are being taught in our schools and colleges;
- supporting robust R&D on effective STEM education practices that increase content knowledge and retention of STEM students and teachers;
- broadening participation of underrepresented groups, geographic regions, and types of institutions in all S&E fields;
- providing scholarships and fellowships to graduate and undergraduate students in STEM fields; and
- recognizing outstanding efforts in STEM education and mentoring.

The FY 2008 Request includes programs that support efforts to prepare a diverse, globally-engaged workforce and strengthen K-12 STEM education by enhancing our understanding of how students learn and applying that knowledge to train highly qualified teachers, develop effective curricular materials, and improve student learning. EHR's Budget Request proposes new and ongoing efforts that prepare the workforce by:
- developing interdisciplinary approaches to teaching and learning;
- stimulating institutional transformations via interdepartmental and interdisciplinary efforts to improve STEM education at all levels;
- developing instructional materials and methods for K-12, undergraduate, and graduate STEM education that reflect current knowledge, employ appropriate technology, and are informed by educational research; and
- promoting programs that increase public interest, understanding, engagement, and lifelong learning in STEM.

EHR's broadening participation efforts increase our Nation's ability to compete for and retain highly-skilled American workers by:
- building innovative and effective collaborations and partnerships to attract individuals from underrepresented groups into STEM;
- strengthening comprehensive planning and strategic implementation at minority-serving institutions;
- increasing pathways and lowering barriers from secondary to post-secondary STEM education; and
- supporting research, dissemination of research, and extension services in education that will lead to a larger and more diverse domestic STEM workforce.

NSF is the principal source of federal support for strengthening STEM education across all levels and is uniquely positioned to lead the Nation in STEM education due to its focus on STEM education research. EHR is working closely with the Academic Competitiveness Council (ACC) to continue to evaluate its portfolio of education programs in order to ensure U.S. students receive the highest quality STEM education. EHR programs increase American competitiveness in the global economy and support NSF's underlying strategy of integration of research and education.

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

FY 2007 Request, EHR………….…….………………………………………………............…$716.22

Research on Learning in Formal and Informal Settings (DRL) +$7.50

Although total support for Research and Evaluation on Education in Science and Engineering (REESE) is level with the FY 2007 Request, $7.50 million of funds that had been previously directed to project and program evaluation efforts will be available for core REESE activities. Project and Program Evaluation will be a new budget line in DRL, funded at $7.50 million.

Undergraduate Education (DUE) +$13.42

To further strengthen NSF's emphasis on increasing the quality and quantity of the science and engineering workforce, and the extent to which undergraduate students are well prepared for an increasingly technological global society, EHR will increase funding for the following programs: Advanced Technological Education (ATE), Course, Curriculum, and Laboratory Improvement (CCLI), STEM Talent Expansion Program (STEP), National STEM Education Digital Library (NSDL), and Federal Cyber Service: Scholarship for Service (SfS). Funding for the Robert Noyce Scholarship program and for Excellence Awards in Science & Engineering (EASE) is level with the FY 2007 Request. Support for the Math and Science Partnership (MSP) program is level with the FY 2007 Request. Approximately $30.0 million will be available for new MSP awards in FY 2008. MSP will coordinate its efforts with other education programs at NSF, the Department of Education, and state-funded efforts.

Graduate Education (DGE) +$8.93

Funding for the Graduate Research Fellowship (GRF) program will increase by $8.93 million over the FY 2007 Request, supporting an additional 200 graduate students. Funding for the Graduate Teaching Fellows in K-12 Education (GK-12) program and for the Integrative Graduate Education and Research Traineeships (IGERT) program is level with FY 2007.

Human Resource Development (HRD) +$4.53

Support increases by $4.53 million for the Centers of Research Excellence in Science and Technology program. The remaining HRD programs, which emphasize broadening participation in the S&E workforce, are funded at the FY 2007 Request. Many HRD programs are focal points for linking EHR activities with NSF's R&RA directorates to strengthen collaborations that integrate research and education. Support for these highly successful and respected programs will aid in addressing national S&E workforce needs to ensure a scientifically literate population and a robust supply of qualified experts across all fields.

Subtotal, Changes +$34.38

FY 2008 Request, EHR ……………………………………………………………………........$750.60

Summary of Major Changes in Directorate-Wide Investments	***(Dollars in Millions)***
FY 2007 Request, EHR……………………………………………………………………..........…	**$716.22**
Preparing the Workforce of the 21st Century	+$12.85
Transformational Facilities and Infrastructure	+$0.50

Preparing the Workforce of the 21st Century — +$12.85

- ATE increases by $5.12 million to $51.62 million. ATE will support 15-20 additional projects to improve the education of technicians in advanced technology areas and initiate one additional targeted research project.
- STEP increases by $3.20 million to $29.70 million. The increase will allow support of three additional projects to increase the number and diversity of students majoring in STEM fields.
- CREST increases by $4.53 million to $29.53 million. CREST expects to make up to eight new awards, including up to four new centers with special emphasis on those targeting innovation in nanotechnology and/or cyberinfrastructure.

Taken together these increases will strengthen NSF's efforts to promote innovation and develop a strong S&E workforce by broadening participation of underrepresented groups and types of institutions in STEM, two areas of emphasis in the ACI.

Transformational Facilities and Infrastructure — +$0.50

Support for NSDL will increase by $500,000 to $16.50 million. NSDL will support additional projects that select, catalog, and maintain digital resources for college classes and student projects.

Other

- Graduate Fellowships and Traineeships. — +$8.93
  This increase will support an additional 200 graduate students in the Graduate Research Fellowship program. Funding will remain equal to the FY 2007 Request for Graduate Teaching Fellows in K-12 Education (GK-12) and Integrative Graduate Education and Research Traineeships (IGERT).
- Research and Evaluation on Education in Science and Engineering (REESE). — +$7.50
  Although total support for Research and Evaluation on Education in Science and Engineering (REESE) is level with the FY 2007 Request, $7.50 million of funds that had been previously directed to project and program evaluation efforts will be available for core REESE activities, effectively increasing the REESE budget.
- Course, Curriculum, and Laboratory Improvement (CCLI). — +$3.50
  The increase will support new projects, with emphasis on ways to assess student learning, improve undergraduate curricula, and enhance faculty expertise.
- Scholarships for Service/Cybercorps (SfS). — +$1.10
  SfS will fund an additional scholarship grant, supporting an additional three cohorts of students who will become information assurance and computer security professionals.
- Cyber-enabled Discovery and Innovation (CDI)
  Within funding for its portfolio, EHR will provide $5.0 million for the new NSF-wide investment, Cyber-enabled Discovery and Innovation (CDI). EHR will fund proposals that study topics at the interface of information technology and education.

Subtotal, Changes — +$34.38

FY 2008 Request, EHR ………..…………………………………………………………..........$750.60

NSF-WIDE INVESTMENTS

In FY 2008, the Directorate for Education and Human Resources 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 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Cyber-enabled Discovery and Innovation (CDI)	-	-	$5.00	$5.00	N/A
Cyberinfrastructure	15.22	16.00	16.50	0.50	3.1%
International Polar Year	2.95	2.00	2.00	-	-
Mathematical Sciences	1.96	1.09	-	-1.09	-100.0%
National Nanotechnology Initiative	3.24	3.00	3.10	0.10	3.3%
Networking and Information Technology R&D	3.88	3.90	9.00	5.10	130.8%

EHR's support for the new **Cyber-enabled Discovery and Innovation** investment will include the study the impact of information technology on educational practice, new approaches to using technology in education, application and adaptation of technologies to promote learning, the effects of technology on learning, and up to four new CREST centers that target nanotechnology and/or cyberinfrastructure.

EHR's **cyberinfrastructure** support totals $16.50 million, an increase of $500,000 over the FY 2007 Request, and funds the NSDL, an online network of learning environments and resources for STEM education at all levels in both formal and informal settings. NSDL will fund projects that provide stewardship for the content and services needed by major communities of learners and projects that develop services to support users, collection providers, and integration efforts, and enhance the impact, efficiency, and value of the library.

EHR will provide $2.0 million in FY 2008 for activities that support education and outreach goals of the **International Polar Year** (IPY). EHR will engage the public through projects such as museum exhibits, large format films, and television and radio documentaries. EHR will also work to develop field experiences in polar research for college students and K-12 educators and help teachers bring polar research to their classrooms.

With the conclusion of the **Mathematical Sciences** priority area in FY 2007, key components of this investment will be transferred to core programs for continued support.

FY 2008 **National Nanotechnology Initiative** (NNI) support is $3.10 million, an increase of $100,000 over the FY 2007 Request. It will provide continuing support for nanoscience education activities.

FY 2008 support for **Networking and Information Technology R&D** (NITRD) totals $9.0 million, an increase of $5.10 million over the FY 2007 Request, continuing support for information technology education activities and initiating support for the new NSF-wide investment, Cyber-enabled Discovery and Innovation.

Additional detail may be found in the NSF-wide Investments 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. In FY 2006, COVs were held for the following programs: Teacher Professional Continuum, Advanced Technological Education, CCLI, STEP, GRF, Research on Gender in Science and Engineering, Research in Disabilities Education, and Evaluative Research and Evaluation Capacity. In FY 2007 COVs are planned for SfS, Historically Black Colleges and Universities – Undergraduate program, Tribal Colleges and Universities program, NSF Scholarships in STEM and Excellence Awards in Science and Education.

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.

EHR has taken an active role in the Academic Competitiveness Council (ACC), leading or co-leading and providing a number of active and engaged members for all three ACC work groups. There has been significant interagency coordination and conversation on broad national STEM education goals and metrics, which has led NSF to a better understanding of its role in the overall federal portfolio.

Evaluation of program effectiveness is a priority for the Foundation, and is a particular emphasis for its STEM education projects and programs. To that end, the Directorate for Education and Human Resources (EHR) has added a senior evaluation advisor to its senior management team, and all EHR solicitations specifically require that proposals include project-level evaluation plans. EHR also conducts a number of program evaluation activities on an ongoing basis to determine how effectively its programs are using current learning models in developing innovations, contributing to the knowledge base on STEM education, and building a community of practitioners and scholars in STEM education.

PERFORMANCE

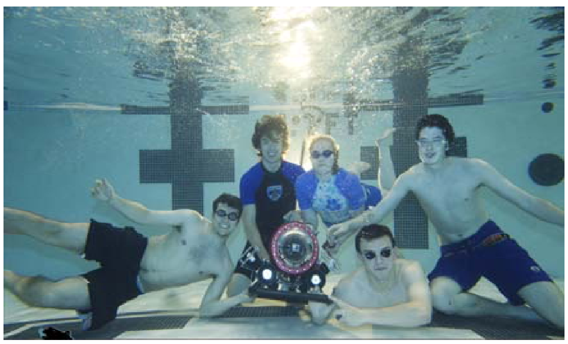
The FY 2008 Budget Request is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals stated in the FY 2006-2011 Strategic Plan. These goals provide an overarching framework for progress in fundamental research and education and facilitate budget and performance integration.

Education and Human Resources
By Strategic Outcome Goal
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Discovery	$68.94	$66.13	$71.21	$5.08	7.7%
Learning	610.39	624.92	653.96	29.04	4.6%
Research Infrastructure	14.82	15.52	15.99	0.47	3.0%
Stewardship	6.11	9.65	9.44	-0.21	-2.2%
Total, EHR	$700.26	$716.22	$750.60	$34.38	4.8%

Totals may not add due to rounding.

Recent Research Highlights



The Polar Submersibles ROV team gets wet in a practice session in Fairbanks, Alaska. *Credit: Patrick Endres.*

► **Marine Advanced Technology Education Center Organizes Remotely Operated Vehicle Competition for Students:** In June 2005, students from around the United States gathered at the NASA Johnson Space Center's Neutral Buoyancy Lab for the fourth annual international Student Remotely Operated Vehicle (ROV) competition. The competition is coordinated every year by the Marine Advanced Technology Education (MATE) Center at Monterey Peninsular College in Monterey, Calif., and the Marine Technology Society's ROV Committee. MATE is an NSF-funded Advanced Technological Education Center of Excellence. More than 2,000 students, from middle schoolers to college seniors, have participated in the competition since it began in 2001. Currently more than 60 organizations and 70 industry professionals support the events by contributing funds, facilities, equipment, building materials, and time and technical expertise as team mentors, judges, and technical advisors. The MATE center is partnering with the National Office for Integrated and Sustained Ocean Observations and the Ocean Research Interactive Observatory Networks (ORION) program to challenge teams to develop ROVs to support ocean observing systems in the 2006 competition. (DUE)

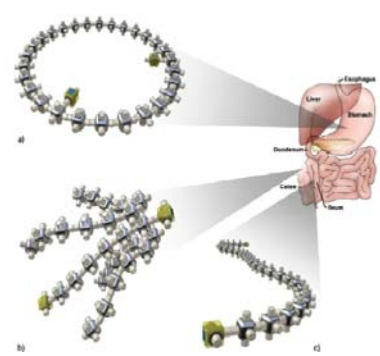
Research on Environmental Sustainability of Semi-Arid Coastal Areas (RESSACA) logo. *Credit: Texas Engineering Experiment Station.*

► **Texas Students and Teachers Study Water Health, Help Decision Makers:** Eighteen major research projects are either currently underway or have been completed since October 2002, when the Research on Environmental Sustainability of Semi-Arid Coastal Areas (RESSACA) project began at Texas A&M University, Kingsville. RESSACA is funded by NSF's Centers of Research Excellence in Science and Technology (CREST) program, which seeks to enhance the research capabilities of minority-serving institutions. RESSACA's results have provided stakeholders in South Texas with information for groundwater management and decision-making. Its current research on sustainable technologies includes biofiltration for wastewater gas emissions, as well as the construction of wetlands for effluent treatment and water reuse. Its planned river-analysis model for the Lower Rio Grande Basin should help with broader water management issues. On the education front, the RESSACA program is seeking to increase high-school students' interest in science and engineering careers. Its Research Education for Teachers program is designed to enhance the skills of high-school teachers and encourage them to increase laboratory or field-based learning in their classrooms. (HRD)

Students learn from the Oglala Lakota College robotics project. *Credit: Mike Fredenberg.*

► **Native American Students Work to Improve Community Environment:** Oglala Lakota College (OLC), on South Dakota's Pine Ridge Reservation, is using NSF funding to improve its curriculum in science, technology, engineering and mathematics education, with an emphasis on environmental sciences and related analytical fields. The project's impact on the enrollment of American Indian students has been significant, particularly in information technology, where their numbers have quadrupled in the past four years. The project has had a similar impact on academic achievement. In Calculus I, for example, the rate of successful completion has grown from 21% before the project started, to approximately 70% in recent years. Currently, fourteen minority students are involved in undergraduate research projects. The program's graduates, highly skilled scientists and technicians, work in their communities, contributing to the economic growth of the reservation. The college's Lakota Center for Science and Technology, developed through support from NSF's Tribal Colleges and Universities Program (TCUP) and other sources, received EPA certification and is now employing OLC graduates to perform water quality analyses for the reservation's water and sewer agencies. The TCUP project is also engaged in preparing the next generation of K-12 teachers for reservation schools, as well as working with current K-12 teachers, improving their knowledge and skills in areas such as robotics. The robotics project will be implemented in about six area schools this academic year. (HRD)

► **Edible Micro-Robots Assist With Delicate Surgeries:** With support from an NSF Graduate Research Fellowship, Robert J. Webster of Johns Hopkins University is designing and testing robotic medical instruments, including two types of very small surgical tools that can extend a doctor's reach into the human body without having to make incisions. Participating in research in Pisa, Italy, Webster has designed and modeled an Assembling Reconfigurable Endoluminal Surgical system (ARES). The idea is to have many interlocking robot modules encased in a pill-like capsule. When the capsule dissolved in the stomach, it would release the robot modules to assemble into one large working unit. The devices could then conduct diagnostic procedures or carry surgical tools to treat disorders of the GI tract. Webster is also creating steerable needle systems and very small and flexible surgical instruments (actively bendable tube-like structures) to perform surgery in confined areas of the body. (DGE)

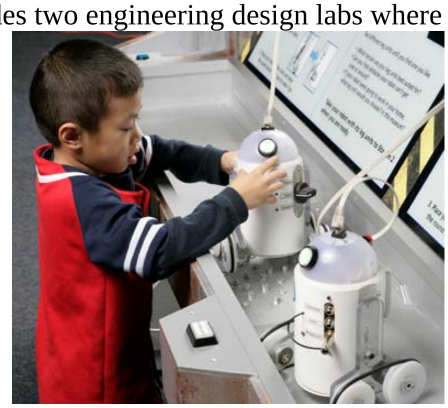


Micro-minimally Invasive Surgical Robots for the Gastrointestinal Tract. *Credit: Institute of Robotics and Intelligent Systems.*

The twelve students (ten UHD and two SJCN students) who presented and were awarded either second or third place in their presentation categories at the Fall 2005 National Sigma Xi Conference in Seattle Washington. *Credit: Drs. Phil Lyons (UHD biology faculty) and Eric Carson (SJCN geology faculty member).*

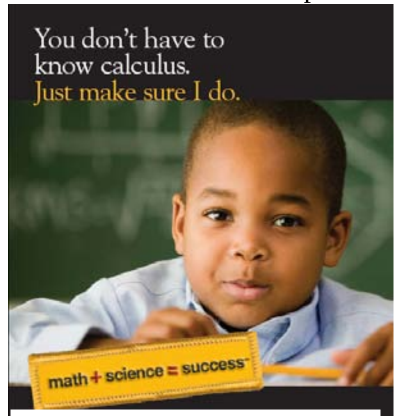
► **Award-Winning Scholars Academy Expands Students' Pathways to Success:** In an effort to increase the number of students receiving undergraduate degrees in the technical disciplines, NSF invests in the Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP). The initiative funds a small number of "Type 2" projects, which seek to understand why students do or do not stay to get their degree. But mostly it funds "Type 1" projects, which look for ways to draw students into the technical fields and then keep them there. One good example of a Type 1 STEP project is the University of Houston-Downtown (UHD) Scholars Academy, which gives undergraduate science and technology majors an opportunity to spend the summer working on research projects with faculty and advanced student mentors. The students come from both UHD and San Jacinto College North (SJCN), a public 2-year community college. In 2004 the Scholars Academy received the Texas Higher Education Star Award, established by the Texas Higher Education Coordinating Board to recognize exemplary contributions toward closing educational gaps in the state. And in November 2005, twelve academy students presented scientific research posters at the Sigma Xi Annual Meeting in Seattle, Washington, and were awarded either second or third place in their presentation categories. (DUE)

► **Science Meets Imagination in Star Wars Exhibit:** The “Star Wars: Where Science Meets Imagination” exhibition, developed by Boston's Museum of Science in collaboration with Lucasfilm, Ltd., explores the possibility that technologies portrayed in science fiction may someday become real. Through hands-on exhibits, immersive experiences, and cutting-edge innovations, the exhibition uses the imagination of Star Wars to promote the goals and standards for technological literacy articulated by the National Academy of Engineering and the International Technology Education Association. The exhibition, funded by NSF's Informal Science Education program, allows museum-goers to learn about fantasy technologies in the Star Wars universe through film clips, props, and models, as well as discover how such ideas become real-life technologies. The exhibition includes two engineering design labs where visitors build and test solutions to challenges; an immersive “object theater” that compares today's robotic technology with capabilities of R2-D2; and a reality interactive where visitors build a spaceport. The exhibition includes for the first time in one handheld device cutting-edge multi-media, American Sign Language (ASL) interpretation and in-depth learning opportunities for use both during and after a visit. Developed specifically for the Star Wars exhibition, this innovative and accessible device enables visitors to extend their exhibit experience by “bookmarking” content and e-mailing it to themselves for later access. It features audio, video, ASL interpretation and closed-captioning. Star Wars: Where Science Meets Imagination premiered at the Museum of Science in Boston and toured science centers in Columbus, OH and Portland, OR. It is now headed to Los Angeles, CA, Fort Worth, TX; Chicago, IL, Philadelphia, PA., and St. Paul, MN. (DRL)



At the 'Robots and People' EDL (Engineering Design Lab) section, the challenge is "How would you design a robot like R2-D2?" *Credit: Museum of Science, Boston.*

► **Parents Have the Greatest Influence on School Performance:** The Partnership for Reform in Science and Mathematics (PRISM), an NSF-funded Math and Science Partnership (MSP) at the University System of Georgia, bridges higher education and K-12 communities as well as parents interested in engaging children to pursue careers in mathematics, the sciences or engineering. After a year of research, PRISM adopted the equation "math + science = success" as its central theme for the first wave of a public awareness campaign early in 2006. To set the stage for the campaign, research instruments were developed by Maguire Associates, a leading educational research firm, in collaboration with the PRISM leadership team of science and mathematics educators from K-12 and higher education. In an important finding from Phase I of the baseline research, researchers found that high school students surveyed in four diverse regions of Georgia overwhelmingly identified their parents – not their teachers, coaches, religious leaders, peers, or celebrities – as exerting the greatest influence on how they do in school. Surprisingly, parents surveyed in the same baseline research underestimated the significance of their influence. An important aspect of the public relations campaign is its coherence with PRISM's other strategies for advancing high-quality mathematics and science education. (DUE/MSP)

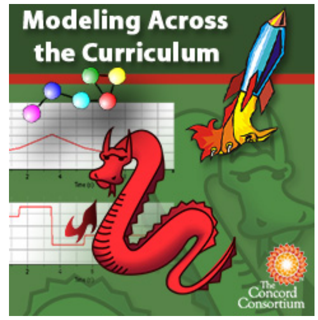


Bus shelter signage used in "math + science = success" public awareness campaign. *Credit: Mindpower Incorporated, Atlanta, GA.*

► **Preparing Science Teachers for High-Need Schools:** The University of California, Los Angeles (UCLA) Robert Noyce Scholarship program is enabling 52 students, who would not otherwise have the financial resources, to pursue a science teaching credential and master's degree at UCLA. The project targets and recruits science majors interested in teaching and who are committed to underserved communities of the urban partner schools in Los Angeles. The Noyce Scholars participate in the research-based Science Teacher Education Program, which prepares teachers to have the commitment, capacity, and resilience to teach in schools with diverse populations that are underrepresented in science, technology, engineering, and math disciplines. A cadre of faculty and peers support students beginning with the first credential year of coursework, through the challenging initial year of teaching and M.Ed. completion, and into the early career years. Teacher isolation is mitigated by developing cohorts within the targeted schools, placement into the schools in pairs, and providing a built-in peer support network. The program emphasizes an inquiry-based approach to teaching science that empowers students and helps overcome the obstacles many urban students face on a daily basis. By using an inquiry-based teaching observation instrument, the Noyce scholars demonstrate a strong understanding of inquiry-based instructional practices. (DUE)

Parents and children delve into science at Family Science Night organized by a UCLA Noyce Scholar. *Credit: The College of Letters and Science, University of California, Los Angeles.*

► **Understanding Science Through Models and Simulations:** The NSF-funded Modeling Across the Curriculum project, spearheaded by the Concord Consortium in Mass., is developing learning tools that enable students to visualize and understand complex scientific phenomena. The tools are easy to use, easy to incorporate into curriculum, freely distributed, and cover all of high-school science from biology to chemistry to physics. The simulations are being used in curricula affecting more than 2000 students in high school science classes around the country. Now in its fifth year, the study of over 40 schools is yielding longitudinal results. Initial results using chemical reaction simulations within the Connected Chemistry curriculum, for example, show significant score gains for those students who used the simulations compared with students who did not. Over 200 schools not in the study are using the curriculum, raising the probability that the project will have a lasting affect on science instruction. More longitudinal studies are being conducted to further understand the properties of the simulations that contribute most to learning science. (DRL)



Modeling across the curriculum logo. *Credit: Paul Horwitz.*

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 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Senior Researchers	4,380	4,400	4,500
Other Professionals	2,440	2,500	2,600
Postdoctorates	290	300	325
Graduate Students	7,075	7,200	7,500
Undergraduate Students	2,610	2,700	3,075
K-12 Students	22,600	23,000	25,000
K-12 Teachers	95,530	96,000	100,000
Total Number of People	134,925	136,100	143,000

In addition, it is estimated that in FY 2006 EHR programs directly impacted more than 400,000 K-12 teachers and more than 16 million K-12 students nationwide. Examples of direct impact include use of EHR-funded instructional materials by teachers and students, and students that benefit from teacher attendance at EHR-supported workshops and training seminars.

RESEARCH ON LEARNING IN FORMAL AND INFORMAL SETTINGS — $222,500,000

The FY 2008 Budget Request for the Division of Research on Learning in Formal and Informal Settings (DRL) is $222.50 million, an increase of $7.50 million, or 3.5 percent, over the FY 2007 Request of $215.0 million.

Research on Learning in Formal and Informal Settings Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Research on Learning in Formal and Informal Settings	$215.58	$215.00	$222.50	$7.50	3.5%
Major Components:					
Discovery Research K-12	94.92	107.00	107.00	-	-
Informal Science Education (ISE)	62.65	66.00	66.00	-	-
Research and Evaluation on Education in S&E	51.07	42.00	42.00	-	-
NSF Academies for Young Scientists	6.94	-	-	-	N/A
Project and Program Evaluation	-	-	7.50	7.50	N/A

About DRL:

The Division of Research on Learning in Formal and Informal Settings advances the coherent integration of science, technology, engineering, and mathematics (STEM) education research, development, evaluation, and synthesis activities. DRL focuses on the full spectrum of basic and applied research in STEM education in both formal and informal settings, at all levels. There is a strong emphasis on improving STEM teaching and learning in the K-12 domain through cutting-edge development and applied research.

DRL programs provide national leadership for advancing discovery and innovation at the frontiers of STEM teaching and learning in the K-12, undergraduate, and graduate settings, and in lifelong learning. The Division is committed to improving STEM learning, particularly in K-12 schools, and in informal education environments; advancing equity and participation in STEM for all; and integrating research and practice. DRL research and development addresses significant educational challenges, including preparing and supporting highly qualified teachers in the STEM disciplines with strong, integrated knowledge of the disciplines and of pedagogy. DRL sponsors the design of research-based K-12 learning tools, resources, and materials that embody high expectations for all students, and studies and evaluations of their strategic implementation and impact. Research in DRL addresses issues of STEM learning at the undergraduate and graduate levels, and across the lifespan. The Division is concerned with expanding the number of students interested in and educated for careers in STEM fields and ensuring that the citizenry has the opportunities to continue their learning of science in a variety of exciting and compelling venues.

DRL Priorities for FY 2008:

DRL's major priorities include the REESE, DRK-12 and ISE programs, as well as significant emphasis on evaluation research and initiatives.

Research and Evaluation on Education in Science and Engineering (REESE) supports basic and applied research and evaluation that enhances understanding of STEM learning and teaching. The program seeks proposals for syntheses of research and evaluation in order to accumulate knowledge, identify gaps, and integrate across literatures and disciplines. REESE also supports empirical studies that advance discovery and innovation at the frontiers of STEM learning. The REESE program spans formal and informal education and all stages of learners, including undergraduate, graduate and adult learners. The program encourages collaborations of social scientists and cognitive scientists with experts in teaching and learning in the STEM disciplines.

Discovery Research K-12 (DR-K12) supports applied research and innovation aimed at improving STEM education at the K-12 level. The research and evaluation in DR-K12 projects focus on K-12 instructional resources and tools developed with NSF funding, and includes development, implementation, and evaluation activities conducted in K-12 settings. Discovery Research addresses problems generated by practice and implementation and is focused on targeted, strategic interventions rather than implementation of educational innovations at large-scale. The program allows for continued work on efforts to develop and evaluate cutting-edge materials in K-12 STEM.

Informal Science Education (ISE) supports the design and development of experiences that encourage learning in informal settings and that promote public engagement with, and understanding of, the STEM disciplines. ISE projects advance leading-edge, state-of-the art efforts to expand the venues and opportunities for science learning, for all learners at all ages. Projects that strengthen infrastructure, engage underserved audiences, involve the public, and introduce innovative uses of technologies will be of highest priority.

Project and Program 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 2007:

- The FY 2008 Request for **REESE** is $42.0 million, equal to the FY 2007 Request, but EHR's overall Project and Program Evaluation work will no longer be part of this budget line. This translates into an additional $7.50 million for REESE, which will be used to fund collaborations with the Research and Related Activities (R&RA) directorates on education research projects designed for stronger scientific workforce development.

- The **Project and Program Evaluation** line supports evaluation efforts for all EHR programs. The $7.50 million in this budget line reflects the consolidation of funding in a single location in the budget display. Previously funding was included in program budgets.

UNDERGRADUATE EDUCATION $210,220,000

The FY 2008 Budget Request for the Division of Undergraduate Education (DUE) is $210.22 million, an increase of $13.42 million, or 6.8 percent, over the FY 2007 Request of $196.80 million.

Undergraduate Education Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Curriculum, Laboratory and Instructional Development	$87.93	$86.50	$93.70	$7.20	8.3%
Workforce Development	60.77	64.30	70.52	6.22	9.7%
Math and Science Partnership	63.17	46.00	46.00	-	-
Total, DUE	$211.86	$196.80	$210.22	$13.42	6.8%
Selected Programs:					
Advanced Technological Education	45.40	46.50	51.62	5.12	11.0%
Course, Curriculum, and Laboratory Improvement	38.43	34.00	37.50	3.50	10.3%
Robert Noyce Scholarship Program	8.91	10.00	10.00	-	-
Scholarship for Service	10.41	11.00	12.10	1.10	10.0%
STEM Talent Expansion Program	25.36	26.50	29.70	3.20	12.1%

Totals may not add due to rounding.

About DUE:

DUE is the NSF focal point for transforming undergraduate STEM education to meet the needs of the 21st century. DUE's objective is to increase the quality and quantity of the science and engineering workforce, and the extent to which all undergraduate students are well prepared for an increasingly technological global society. DUE programs create leverage for institutional change. They emphasize innovation and ongoing improvement in curricula, teaching procedures, and laboratories, so that the next generation is always learning by using the tools and methods of inquiry that working professionals use. Grants are made to 2- and 4-year colleges and universities. Collaborations among institutions, and between higher education, industry, and the K-12 sector are encouraged. So that best practices penetrate deeply into the community, DUE grants provide for faculty development, support for new instructional materials, the reform of courses, laboratories, and curricula, and assessment of outcomes.

DUE Priorities for FY 2008:

- The **Course, Curriculum, and Laboratory Improvement** (CCLI) program funds the development of new learning materials, faculty expertise, and assessment and evaluation. CCLI is the core program in the DUE portfolio. It supports the innovative educators who build the STEM workforce, and it keeps the teaching enterprise aligned with the pace of change in the knowledge base and technical capability of the STEM disciplines.

- 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 that leads to improvement in persistence to the associate or baccalaureate degree in STEM. The transformational STEM learning experiences gained during the early undergraduate years for both STEM and non-STEM majors will better equip students to participate in more advanced discovery-based experiences, pursue STEM careers, and/or better understand the relevance of STEM disciplines to the workplace and society. Planned collaborations with states, especially partnerships with governors' offices and state-wide systems of higher education, is expected to greatly enhance NSF's institutional reform efforts at the undergraduate level.

- The **National STEM Education Digital Library** (NSDL) is an online network of resources for STEM education at all levels in both formal and informal settings. It funds projects that provide stewardship for the content and services needed by major communities of learners. It also funds projects that develop services to support users, collection providers, and integration efforts, and enhance the impact, efficiency, and value of the library.

- **Excellence Awards in Science & Engineering** (EASE) are designed to recognize achievement in education. EASE includes the Distinguished Teaching Scholars (DTS) track, which recognizes distinguished individuals who integrate their discipline scholarship with education, the Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST), and the Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM).

- 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 **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.

- As a crosscutting program housed in DUE, the **Math and Science Partnership** (MSP) at NSF is a research and development effort to build capacity and integrate 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 K-12 students. MSP currently supports (a) Comprehensive Partnerships that implement change across the K-12 continuum in mathematics and/or science; (b) Targeted Partnerships that focus on a narrower grade range or disciplinary focus in mathematics and/or science; (c) Research, Evaluation and Technical Assistance (RETA) projects that develop tools to assess the Partnerships' progress and make their work more strategic, build evaluation capacity and conduct focused research; and (d) Institute Partnerships: Teacher Institutes for the 21st Century that respond to 21st century needs for accomplished teachers with expertise in school mathematics and the sciences.

MSP builds upon the knowledge base it has developed to emphasize the preparation of new teachers and the ongoing professional development of inservice teachers through critical collaborations among STEM departments in higher education, colleges of education, school districts, state level teacher certification officials, and business and industry. New *Targeted Partnerships* will emphasize the critical junctures of K-12 STEM education that impede student progress in mathematics and science between (a) middle and high school and (b) high school and college. New *Teacher Institutes* will support the development of school-based teacher intellectual leaders with deep content expertise and the leadership skills that are important for strategically navigating the complex curricular, instructional, and classroom assessment challenges embedded within the critical years of transition.

MSP leverages its cross-cutting attributes through integration of its work with other STEM educational programs at NSF, and through ongoing coordination with the Department of Education (ED) and its state-funded MSP sites. Within NSF's Partnerships and RETA projects, innovative, needed tools and other deliverables are in various stages of development and are being piloted or used by both NSF's and ED's Partnerships, as well as by other educational programs at NSF. These include (a) instruments to assess teachers' knowledge of mathematics/science content and how this content is used in teaching, especially for middle school; (b) an innovative system to help school principals identify the instructional methods teachers use, spot instructional problems, and make decisions that inform teacher development, towards improved student achievement; and (c) deliverables that inform and improve evaluation. NSF coordinates with ED and state MSP sites through co-management of two Partnerships jointly funded by the two agencies; sharing of tools and promising strategies developed and field-tested by NSF's MSP projects; and substantial cooperation in the field between projects/partners funded by NSF and those connected with state departments of education and state MSP sites. Almost two-thirds of NSF's funded Partnerships report direct collaboration with state MSP sites.

Changes from FY 2007:

<u>Curriculum, Laboratory, and Instructional Development Programs</u>

- The FY 2008 Request for **CCLI** is $37.50 million, an increase of $3.50 million from the FY 2007 Request of $34.0 million. New funds will permit an increase in the success rate for this core program.

- The FY 2008 Request for **STEP** is $29.70 million, an increase of $3.20 million over the FY 2007 Request. STEP will support student discovery-based experiences; cyber-enabled learning; innovative instructional delivery; adaptive learning strategies; the education of future teachers; and discovery-based experiences for current teachers to strengthen their educational practice.

- The FY 2008 Request for **NSDL** is $16.50 million. This is an increase of $500,000 over the FY 2007 Request. These additional funds will allow an increase in both the number of users of NSDL and in the capability to offer customizable user interfaces to the digital library.

<u>Workforce Development Programs</u>

- FY 2008 funding for **SfS** is increased by $1.10 million over the FY 2007 Request to $12.10 million, which will to support an additional three cohorts of up to 10 students each.

- In FY 2008, funding for **ATE** is increased to $51.62 million, $5.12 million above the FY 2007 Request. The ATE program has two new opportunities in FY 2008 - small grants for institutions new to the ATE program and targeted research in technician education. Additional funds will support 15 to 20 additional small grants to broaden participation and one additional targeted research project.

Math and Science Partnership

- The FY 2008 Request for **MSP** is level to the FY 2007 Request of $46.0 million. Approximately $30.0 million will be available for new awards in FY 2008. Awards will be made for a small number of new MSP *Targeted Partnerships* and *Teacher Institutes for the 21st Century* that emphasize the critical junctures in K-12 mathematics and science education between middle and high school, and between high school and college. These efforts will engage middle and high school teachers and their students in educationally appropriate and relevant topics that support the high-leverage fields of the physical sciences and engineering, as delineated for NSF in the *American Competitiveness Initiative*, coupled with the mathematics content and technology essential for study and success in these areas. Informed by the most promising ideas and strategies in existing NSF programs and by a rigorous system of both project- and program-level evaluation, NSF-funded scientists and educators will bring the expertise and capability needed to provide the initial research and development necessary to grow innovative ideas and approaches to STEM education and take them "to market" through demonstration sites. These sites will provide opportunities for educators not affiliated with the sites to observe and learn in depth about their work in order to replicate/adapt well-researched and field-tested findings and products to their local educational settings. Funds will also be used for data collection, evaluation, and knowledge management and dissemination, consonant with program and Academic Competitiveness Council goals and requirements.

GRADUATE EDUCATION $169,500,000

The FY 2008 Budget Request for the Division of Graduate Education (DGE) is $169.50 million, an increase of $8.93 million, or 5.6 percent, over the FY 2007 Request of $160.57 million.

Graduate Education Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Graduate Education	$153.07	$160.57	$169.50	$8.93	5.6%
Major Components:					
Integrative Graduate Education and Research Traineeships (IGERT)	23.76	25.00	25.00	-	-
Graduate Research Fellowships (GRF)	86.35	88.57	97.50	8.93	10.1%
Graduate Teaching Fellows in K-12 Education (GK-12)	42.96	47.00	47.00	-	-

About DGE:

DGE investments support graduate students and innovative graduate programs that 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 5,375 graduate fellowships and traineeships will be supported NSF-wide in FY 2008.

DGE Priorities for FY 2008:

- 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 1,510 IGERT trainees will be supported across NSF in FY 2008.

- The **Graduate Research Fellowship** 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 2008, priorities include broadening participation in the applicant and awardee pools.

Since 1952, over 41,000 U.S. students have received GRFs. In FY 2008 approximately 2,950 fellows will be supported, primarily with DGE funds. The Directorates for Engineering (ENG) and Computer and Information Science and Engineering (CISE) also provide support for the GRF program. Although at early stages of their careers, Fellows begin building distinguished records of accomplishment.

- The **Graduate Teaching Fellows in K-12 Education** program 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 915 GK-12 fellows will be supported NSF-wide in FY 2008. Through collaboration with the Office of Cyberinfrastructure (OCI), GK-12 is developing opportunities for fellows to explore CI applications in research and education.

Each of the three major DGE programs recognizes the growing significance of the changing global environment for future scientists and is taking steps to bring more international emphasis and provide more opportunities to students for expanding their knowledge of research and education in other nations and international issues affecting STEM careers.

Changes from FY 2007:

- GRF is widely recognized as a unique fellowship grant program because it supports the broad array of science and engineering disciplines across all fields as well as international research activity. In FY 2007, DGE received over 8,100 applications for its highly prestigious and competitive awards, and was able to award approximately 900 fellowships. The EHR FY 2008 Request for GRF is $97.50 million, an increase of $8.93 million over the FY 2007 Request. This increase will provide support for an additional 200 graduate students.

HUMAN RESOURCE DEVELOPMENT $148,380,000

The FY 2008 Budget Request for the Division of Human Resource Development (HRD) is $148.38 million, an increase of $4.53 million, or 3.1 percent, over the FY 2007 Request of $143.85 million.

Human Resource Development Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Undergraduate/Graduate Student Support	$72.44	$82.85	$82.85	-	-
Research and Education Infrastructure	32.36	44.00	48.53	4.53	10.3%
Opportunies for Women and Persons with Disabilities	14.95	17.00	17.00	-	-
Total, HRD	$119.75	$143.85	$148.38	$4.53	3.1%

Totals may not add due to rounding.

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.

HRD Priorities for FY 2008:

The FY 2008 Request supports 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 Research and Related Activities (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).

<u>Undergraduate/Graduate Student Support</u>

- **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 2008.

- The **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 2008, in addition to continuing to strengthen STEM programs at the Nation's HBCUs, HBCU-UP will allocate resources to encourage education research and develop the education research capabilities of HBCUs.

- The **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. TCUP supports teacher education programs, as well as targeted projects to improve STEM programs at TCUs. Ten new awards are planned in FY 2008.

<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 2008 AGEP will facilitate bridging of LSAMP BD fellows into AGEP, provide resources to enhance recruitment of new enrollees into AGEP, and enhance retention/advancement of AGEP student participants.

- **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 (the HBCU institutional capacity building activity within CREST, which is also known as Research Infrastructure in Science & Engineering, or “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.

<u>Opportunities for Women and Persons with Disabilities</u>

- The **Research on Gender in Science and Engineering** (GSE) program seeks to broaden the participation of girls and women in all fields of STEM education by supporting research, dissemination of research, and extension services in education that will lead to a larger and more diverse domestic science and engineering workforce.

- 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 will make a total of 1-2 additional awards in FY 2008, pursuing “talent” irrespective of “ability” and working towards parity in the U.S. STEM workforce by providing opportunities for persons with disabilities to enter and participate at all levels of STEM education**.**

Changes from FY 2007:

- **CREST** funding for FY 2008 is $29.53 million, an increase of $4.53 million over the FY 2007 Request. This increase will be used to support up to four new CREST center awards in addition to up to five HBCU-RISE awards. CREST awards strengthen research and education in minority-serving institutions and increase student matriculation in STEM disciplines. In addition, CREST will continue pursuing its goal to broaden participation by building the research capability of minority-serving institutions.

H-1B NONIMMIGRANT PETITIONER FEES $100,000,000

The FY 2008 H-1B Nonimmigrant Petitioner Fees are projected to be $100.0 million, equivalent to the FY 2007 projection.

H-1B Nonimmigrant Petitioner Fees Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	Change over FY 2007 Estimate Amount	Percent
H-1B Nonimmigrant Petitioner Fees Funding	$99.40	$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 former 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 was renamed in 2006 from CSEMS to Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM).

Since its inception the low-income scholarship program has received approximately 1,700 proposals from all types of colleges and universities and has made awards for 671 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. Approximately 100 awards are expected to be made in FY 2008.

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. Categories of awards include: (1) *Youth Projects* for school-age children, grades 6-12; (2) *Comprehensive Projects* that include opportunities for STEM teachers to gain familiarity with IT that can be used in 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. In FY 2007, current awardees also have the opportunity to apply for two-year *Traditional Project Renewals* to continue projects that have the potential to significantly increase the understanding of effective strategies for the engagement of diverse populations of students and teachers.

The ITEST portfolio consists of 77 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 projected $79.5 million federal investment, ITEST impacts an estimated 80,000 students (grades 6-12), 3,700 teachers and 1,500 parents / caregivers. Interest in ITEST continues. In FY 2006, ITEST received 146 full proposals, a 15% increase over the 2005 submission rate and a 36% increase over the 2004 submission rate. It is anticipated that submissions for 2007 and 2008 will be comparable to 2006.

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 used 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, called 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 was a demonstration project in FY 2006 and thus no funds are requested in FY 2008.

H-1B Financial Activities from FY 1999 - FY 2006

(Dollars in Millions)

	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
Receipts	**$26.61**	**$48.61**	**$88.34**	**$61.04**	**$65.34**	**$0.57**	**$83.68**	**$105.32**
Obligations incurred								
Computer Science, Engineering, and Mathematics Scholarships	0.26	23.16	68.37	34.69	25.30	33.91	0.54	80.95
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	18.45
Total Obligations	**$0.26**	**$25.06**	**$78.51**	**$57.31**	**$46.57**	**$57.28**	**$25.95**	**$99.40**
Unobligated Balance end of year	$26.35	$49.89	$59.72	$63.45	$83.90	$29.10	$89.58	$98.19

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.

Explanation of Carryover

With regard to the carryover into FY 2007, significant amounts of receipts arrived late in the fiscal year and there was not adequate time to obligate the total amounts. NSF is planning earlier deadlines for the S-STEM and ITEST programs in FY 2007 so that it can make awards from H-1B Visa Funds earlier in the fiscal year, and plans to move the deadlines even earlier starting in FY 2008. A carryover from FY 2007 into FY 2008 is likely, but it is expected to be less than the carryover into FY 2007.

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION $244,740,000

The FY 2008 Budget Request for the Major Research Equipment and Facilities Construction (MREFC) account is $244.74 million, an increase of $4.29 million, or 1.8 percent, above the FY 2007 Request of $240.45 million.

Major Research Equipment and Facilities Construction Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change Over FY 2007 Amount	Change Over FY 2007 Percent
Major Research Equipment & Facilities Construction	$233.81	$240.45	$244.74	$4.29	1.8%

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 2006 Actual	FY 2007 Request	FY 2008 Request	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
Ongoing Projects								
ARRV[1]		56.00	42.00	25.00	-			
ALMA[2]	48.66	64.27	102.07	74.75	42.76	21.44	3.00	-
DOJ Judgment		3.00	-					
EarthScope	49.62	27.40	-					
IceCube	56.44	28.65	22.38	11.33	0.95	-		
NEON[3]		4.00	8.00	20.00	30.00	26.00	12.00	-
OOI[4]		5.12	30.99	80.00	90.00	95.00	30.00	-
SODV	66.03	42.88	-					
SPSM[5]	13.07	9.13	6.55	-				
New Starts								
AdvLIGO[6]		-	32.75	51.43	46.30	15.21	23.73	15.50
MREFC Account Total	$233.81	$240.45	$244.74	$262.51	$210.01	$157.65	$68.73	$15.50

Totals may not add due to rounding.

[1] The recent baseline analysis for ARRV noted the potential for a cost increase of $25.0 million (included in FY 2009).

[2] ALMA is increased by $16.38 million in FY 2007 following a rebaselining completed in FY 2006. Figures for FY 2008 and beyond also reflect the new baseline.

[3] NEON is reduced in FY 2007 to partially cover ALMA's increase. NEON's revised baseline is expected in May 2007 following a Preliminary Design Review (PDR). The amount in FY 2012 reflects the reduced funding in FY 2007 and FY 2008.

[4] OOI is reduced by $8.38 million in FY 2007 to cover the remainder of ALMA's increase. OOI plans to conduct a PDR in December 2007, at which time firmer cost estimates will be available.

[5] The SPSM cost to complete was updated in August 2006. The revised work plan, schedule and estimate were reviewed in detail by an external panel in September 2006 and the estimate for FY 2008 reflects the cost to complete the remaining scope of the project in accordance with the revised schedule.

[6] The AdvLIGO estimate reflects the formal project baseline reviewed by the external panel convened by NSF in June 2006.

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 (NSB). NSF's FY 2008 request for the MREFC account positions the agency to meet the future needs and opportunities of the research community.

In accordance with the plan outlined in "A Joint National Science Board-National Science Foundation Management report on *Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation*,[1]", NSF continues to develop the guiding documentation for the MREFC process. NSF released its first *Facility Plan*[2] in September 2005 and will release its second annual *Facility Plan* in conjunction with this Budget Request. The revised *Guidelines for Planning and Managing the Major Research Equipment and Facilities Construction (MREFC) Account*[3], also known as the *MREFC Guidelines*, were released in November 2005, and the final management document, the *Facility Manual*[4], which incorporates the *MREFC Guidelines*, is expected to be released in FY 2007. All of the projects in the MREFC account are undergoing or have undergone major cost and schedule reviews, as required by these guidelines.

- NSF contracted for two independent cost estimates for the **Alaska Region Research Vessel** (ARRV) in November 2006, which identified a $25.0 million increase. The estimates included a survey of the availability of U.S. shipyards, updates on major equipment quotes and pricing, and escalated labor costs through FY 2009. Accordingly, the ARRV funding profile includes an additional $25.0 million in FY 2009 to cover this cost increase.

- An independent baseline review for the **Atacama Large Millimeter Array** (ALMA) was completed in FY 2006 and resulted in a reduction of scope, a revised cost estimate, and a 24 month extension of the project schedule. Based on this review, the FY 2007 funding requirement increased by $16.38 million above the FY 2007 Request level. NSF will reduce NEON and OOI in FY 2007 to offset this increase.

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[1] 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. (www.nsf.gov/pubs/2005/nsb0577/nsb0577.pdf)

[2] 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)

[3] The *Guidelines for Planning and Managing the Major Research Equipment and Facilities Construction (MREFC) Account* (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)

[4] The revised *Facility Manual* and supplemental modules will provide step-by-step guidance to NSF staff and awardees on 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.

- NSF initiates support for **National Ecological Observatory Network** (NEON) and the **Ocean Observatories Initiative** (OOI) in FY 2007. Both projects will undergo Preliminary Design Reviews (PDRs) on schedule in 2007, after which revised funding profiles will be available. Information on these reviews is provided in the relevant sections of this chapter.

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 the FY 2008 Budget Request meet these criteria.

Projects being considered for MREFC funding undergo a multi-phase review and approval process[5]. This includes a review by the internal NSF MREFC Panel, chaired by the NSF Deputy Director and comprised of the Assistant Directors, the Heads of the Office of Polar Programs (OPP), the Office of Cyberinfrastructure (OCI), the Office of International Science and Engineering (OISE), the Office of Legislative and Public Affairs (OLPA), and the Chief Financial Officer (CFO), the BFA Deputy Director for Large Facility Projects (DDLFP), and the Office of General Counsel (OGC). The MREFC Panel makes recommendations to the NSF Director with attention to criteria such as scientific merit, importance, readiness, and cost-benefit. The Director then selects candidates to send to the NSB for consideration, which then approves, or not, projects for inclusion in future budget requests. The Director, in keeping with NSB prioritization, selects from the group of approved projects those appropriate for inclusion in a particular budget request to the Office of Management and Budget (OMB), and after discussion with OMB, to the Congress.

NSF believes that the highest priority within the MREFC Account must be the current projects. To that end, the FY 2008 Budget requests funding for the Alaska Region Research Vessel ($42.0 million); the Atacama Large Millimeter Array ($102.07 million); the IceCube Neutrino Observatory ($22.38 million); the National Ecological Observatory Network ($8.0 million); the Ocean Observatories Initiative ($30.99 million); and the South Pole Station Modernization project ($6.55 million).

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 one new start in FY 2008: Advanced LIGO ($32.75 million).

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, $244,740,000, to remain available until expended.

[5] The process is described in greater detail in the *MREFC Guidelines*.

Major Research Equipment and Facilities Construction
FY 2008 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Rescission	Carryover/ Recoveries	Transfers	Total Resources	Obligations Incurred/Est.
FY 2006 Appropriation	$193.35	-$2.47	$45.71	-	$236.59	$233.81
FY 2007 Request	240.45	-	2.78	-	243.23	243.23
FY 2008 Request	244.74	-	0.00	-	244.74	244.74
$ Change from FY 2007						$1.51
% Change from FY 2007						0.6%

Totals may not add due to rounding.

<u>Explanation of Carryover:</u>

Within the Major Research Equipment and Facilities Construction (MREFC) appropriation, a total of $2.78 million was carried forward into FY 2007 including $2.61 million for EarthScope. The Office of Polar Programs carried forward $138,209 for the South Pole Station Modernization project and the South Pole Safety and Health project.

FIRST PRIORITY: ONGOING PROJECTS IN FY 2008

Ongoing projects in FY 2008 include:

- the Alaska Region Research Vessel
- the Atacama Large Millimeter Array
- the IceCube Neutrino Observatory
- the National Ecological Observatory Network
- the Ocean Observatories Initiative, and
- the South Pole Station Modernization project.

Information on these projects, as well as information on EarthScope and the Scientific Ocean Drilling Vessel, both of which received their final year of construction funding in FY 2007, follows.

Alaska Region Research Vessel

Project Description: The Alaska Region Research Vessel (ARRV) is proposed to replace the 40-year old R/V *Alpha Helix*, 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 be built to 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 ice (up to 2.5 feet thick) 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 up to 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, while fisheries and 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 is the Program Director for Ship Acquisition and Upgrades, within the Integrative Programs Section (IPS) in the Division of Ocean Sciences in the Directorate for Geosciences (GEO), with additional staff in IPS providing project management assistance. Two section members 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), including the BFA DDLFP, and the OGC. The Awardee will establish a project management office and submit a project execution plan (PEP) for review by NSF. The baseline will be established following the award of the construction contract but prior to any construction funds being released. 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. NSF issued a competitive solicitation for a cooperative agreement for the construction and operation of this ship in October 2006. Proposals were due in January 2007.

The Interagency Working Group for Facilities (IWG-F) 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[6]. An update of this Plan will be published later this year.

Milestones for ARRV are outlined below:

FY 2006 Milestones:
- Prepared and issued a solicitation to build and operate the ARRV via a Cooperative Agreement.

FY 2007 Milestones:
- Complete an external merit review process of proposals received
- Internal management plan approved by NSF
- Bring to the NSB for approval the selection based on the merit reviewed proposals
- Negotiate a Cooperative Agreement with the selected institution
- Awardee establishes the Project Management Office, submits a PEP for review to NSF, 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
- Conduct monthly and in-depth quarterly reviews with NSF oversight, to include on site inspections

FY 2009 Milestones:
- Complete vessel construction and outfitting
- Undergo sea and science trials
- Finalize acceptance and delivery of vessel to operating institution
- Incorporate vessel into the UNOLS ship scheduling process

[6] This report is available online: 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: It was recognized from the outset of R/V *Alpha Helix* operations that the ship was of marginal size and capability for the Alaskan region, and so 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 funded the concept design, detailed design and model testing for a replacement vessel and is prepared to initiate a three-year construction phase.

Based on the results of two independent cost analyses conducted during November 2006, the funding profile has been revised upward, with $25.0 million added in FY 2009. This upward adjustment recognizes the rapid inflation in raw materials and the current and projected strong market conditions in the U.S. shipbuilding industry.

Requested MREFC Funds for ARRV

(Dollars in Millions)

FY 2007 Request	FY 2008 Request	FY 2009 Estimate	Total
$56.00	$42.00	$25.00	$123.00

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	0.30						$0.30	-	$0.30
FY 2006	0.03						$0.03	-	$0.03
FY 2007 Request				56.00			-	$56.00	$56.00
FY 2008 Request				42.00			-	$42.00	$42.00
FY 2009 Estimate				25.00			-	$25.00	$25.00
FY 2010 Estimate					7.50		$7.50	-	$7.50
FY 2011 Estimate					8.00		$8.00	-	$8.00
FY 2012 Estimate					8.50		$8.50		$8.50
FY 2013 Estimate					9.00		$9.00	-	$9.00
Subtotal, R&RA	$2.24		-		$33.00		$35.24		
Subtotal, MREFC		-		$123.00		-		$123.00	
Total, Each Stage		$2.24		$123.00		$33.00			$158.24

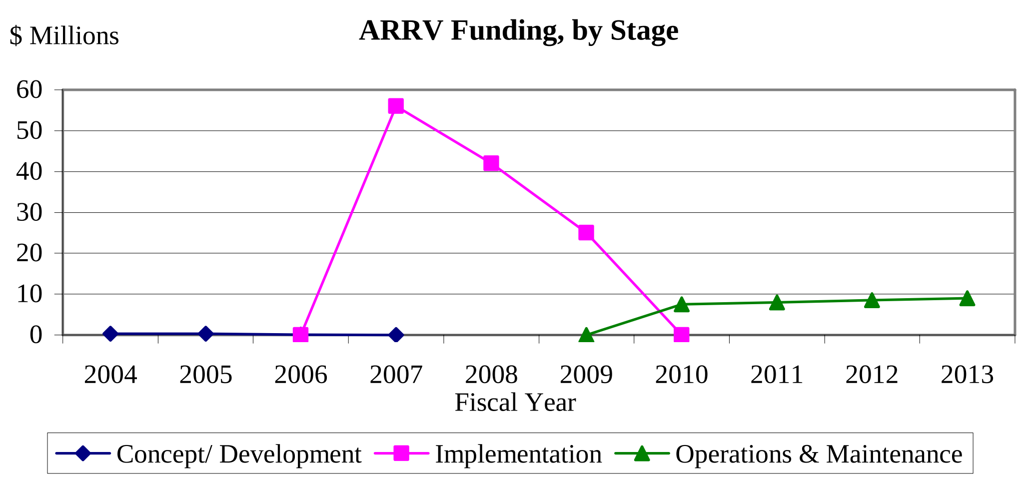
Ship operations are estimated to be approximately $7.50 million for the first full year. The expected operational service life of the ARRV is 30 years after construction is complete. Operations estimates for FY 2010 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

Information 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 begin the construction phase in FY 2007. It is anticipated that the vessel will be constructed over a two-year period, after which it will be ready for sea trials and commissioning. It is anticipated that ARRV will then be ready to conduct science activities within 6 months to a year after construction is completed.

- 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 $7.50 million.



Associated Research and Education Activities: There are successful on-going programs sponsored by NSF as well as diverse opportunities provided by state and local sources, often coordinated through the Arctic Research Consortium of the United States (ARCUS). Some examples of activities that link arctic research and education are a variety of teacher enhancement programs that provide field experience to develop scientific knowledge and integration of this knowledge into teaching practices. Another example includes active participation by K-12 students to regularly collect data on snow and lake ice in areas that are not easily accessible to researchers on a regular basis. There is also a variety of programs that bring visiting scientists and journalists to conduct research and convey this information to the general public. Last, but certainly not least, is the effort to directly include arctic communities into research programs. The ARRV will provide a stable, technically advanced platform for research and educational opportunities in the Arctic, providing a direct link to the marine environment.

Future Science Support: Along with direct operations and maintenance support for the ARRV as part of the Academic Research Fleet, NSF will support research performed using this 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, habitability, and ice capability.

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. 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 planet formation, 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.

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, providing an opportunity to broaden participation in science and engineering by members of under-represented groups.

Partnerships and Connections to Industry: North America and Europe are equal partners in the core ALMA instrument. 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.

From an industrial perspective, 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 (AST) in the Directorate for Mathematical and Physical Sciences (MPS). An NSF advisory group, consisting of representatives from OGC, the Office of Budget, Finance, and Award Management (BFA), and OLPA, serves as a standing ALMA PAT. The BFA DDLFP is a member of the PAT and provides advice and assistance. AST’s external Millimeter Array (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 (JAO), whose staff includes the ALMA Director, Project Manager, and Project Engineer.

Foundation work for the Operations Support Facility (OSF) Technical Building is underway at the 9600 foot level. This building will be the nerve center of ALMA. ALMA personnel will work here, directing the operation of the Array at the 16,570 foot elevation Array Operations Site, collecting data and sending it onward to astronomers around the world. This building will be finished in 2008. *Credit: NRAO/AUI/NSF; Images compliments of Dr. Seiichi Sakamoto of the ALMA Project Office, National Astronomical Observatory of Japan*

Current Project Status: Construction progress continues in FY 2007, both at the site in Chile, and within the ALMA partner countries. The most significant event for the project in FY 2006 was completion of re-baselining reviews initiated due to escalation in cost of the production antennas, civil construction in Chile, and the managerial and technical complexity of an international project. These reviews resulted in a reduction of the core array from 64 to 50 antennas, a revised cost estimate (described below), and a 24 month extension of the project schedule to September 2012.

Major project milestones attained in FY 2006 included:

- Completion of all baseline reviews and approval of a new budget and schedule by all funding agencies
- Completion of ALMA site camp
- Completion of road from base to high-altitude site
- Placement of European production antenna contract
- Placement of antenna transporter contract
- Completion of North American front end integration and commencement of test center operations
- Prototype integration testing began at Socorro NM antenna test facility (interferometry)

Major milestones for FY 2007 are expected to include:

- Completion and provisional acceptance of Array Operations Site (AOS) technical building
- Delivery of first North American production antenna to Chile
- Delivery of first front end to Chile site
- Completion of European front end integration and commencement of test center operations

Major milestones for FY 2008 are anticipated to include:

- Delivery of the second through fifth North American production antennas to Chile
- Testing of interferometry at the mid-level facility in Chile using two antennas
- Transportation of several antennas to the final, high-altitude site in Chile in preparation of commissioning in late 2008 (FY 2009)

Early science operations are expected to commence in 2010 and completion of the construction project and the start of full science operations are planned to occur around the end of 2012.

Funding Profile: A $26.0 million, three-year Design and Development Phase was originally planned for a U.S.-only project, the Millimeter Array. However, after 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 level of $5.99 million. U.S. construction of ALMA was initiated in FY 2002.

The cost of ALMA construction was originally set at $702.0 million, with the U.S. share of the joint array construction established at $344.28 million. The rebaselining reviews resulted in a revised cost estimate for the U.S. share of $499.26 million, within a total construction cost of $998.0 million, and a 24 month extension through to September 2012.

The revised FY 2007 estimate of $64.27 million adopts the new baseline approved by the NSB and is $16.38 million higher than the original FY 2007 Request of $47.89 million. The additional funds are required mainly to service the $183 million antenna contract during FY 2007.

Appropriated and Requested MREFC Funds for ALMA

(Dollars in Millions)

	FY 05 & Earlier	FY06	FY07 Request	FY08 Request	FY09	FY10	FY11	FY 12	Total
ALMA R&D	31.99								$31.99
ALMA Construction	142.31	48.66	64.27	102.07	74.75	42.76	21.44	$3.00	$499.26
Total, ALMA	$174.30	$48.66	$64.27	$102.07	$74.75	$42.76	$21.44	$3.00	$531.25

ALMA Funding Profile

(Obligated Dollars and Estimates in Millions)

	Concept/ Development		Implementation[1]		Operations & Maintenance[2]		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 Actual				48.66	1.50		$1.50	$48.66	**$50.16**
FY 2007 Request[1]				64.27	2.73		$2.73	$64.27	**$67.00**
FY 2008 Request				102.07	8.22		$8.22	$102.07	**$110.29**
FY 2009 Estimate				74.75	12.43		$12.43	$74.75	**$87.18**
FY 2010 Estimate				42.76	16.76		$16.76	$42.76	**$59.52**
FY 2011 Estimate				21.44	20.45		$20.45	$21.44	**$41.89**
FY 2012 Estimate				3.00	23.51		$23.51	$3.00	**$26.51**
FY 2013 Estimate					24.87		$24.87	-	**$24.87**
Subtotal, R&RA	$6.50		-		$111.47		$117.97		
Subtotal, MREFC		$31.99		$499.26		-		$531.25	
Total, Each Stage		**$38.49**		**$499.26**		**$111.47**			**$649.22**

[1]Implementation costs for FY 2008 and beyond are based on the funding profile developed following a rebaselining completed in FY 2006. The FY2007 Request includes an increase of $16.38 million according to that profile.

[2]Operations estimates for FY 2009 and beyond are based on current cost profiles. They will be updated following the review of a proposal for operations expected in mid-FY2007. The expected operational lifespan of this facility is at least 30 years.

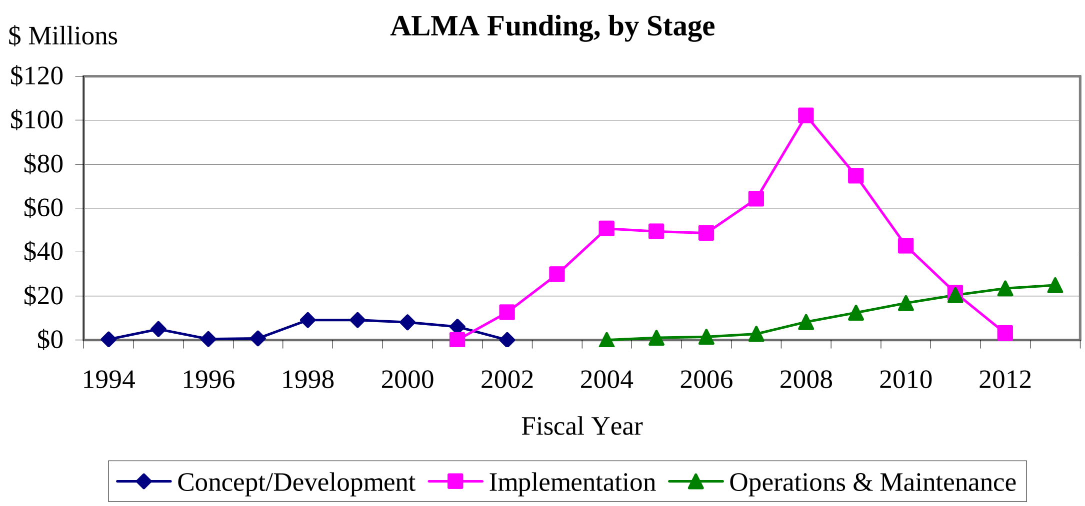
Information pertaining to the data in the table is included below.

- 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 fifty 12-meter antennas having a total collecting area of 5,600 square meters, with four receiver bands extending into the submillimeter. The table describes the U.S. contribution to the rebaselined ALMA project. It does not include funds resulting from Canada's participation of $20 million (FY 2000).

- 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.



<u>Associated Research and Education Activities</u>: 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.

<u>Future Science Support</u>: Peer-review telescope allocation committees provide merit-based telescope time but no financial support. NSF does not provide awards targeted specifically for use of ALMA. Most U.S. users will be supported through NSF or NASA grants to pursue research programs that require use of ALMA.

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.

One of the components of EarthScope is a project to drill an angled hole through a seismically active portion of the San Andreas Fault Zone, creating a San Andreas Fault Observatory at Depth (SAFOD). SAFOD is drilling through the fault to a depth of 3.2 km, obtaining samples and making geophysical measurements within and adjacent to the fault zone, and installing instruments to continuously monitor variations in rock deformation and other parameters during the earthquake cycle. *Credit: www.EarthScope.org*

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 are enabled by EarthScope. Instrumentation firms are collaborating on development for state-of-the-art seismic systems, down-hole instrumentation, and high-precision GPS antenna designs.

Management and Oversight: The EarthScope Program Director, located in the Earth Sciences (EAR) Division in GEO, provides NSF oversight. The EAR Deep Earth Processes Section Head and a PAT including the BFA DDLFP and staff from GEO, OGC, and the Office of Budget, Finance and Award Management (BFA), 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: Downhole measurements and experiments were conducted at the San Andreas Fault Observatory at Depth (SAFOD) site during 2006. A sensor string was installed during July 2006 to record data through the winter. Analysis of sidewall cores collected in the deepest part of the hole provides tantalizing evidence of what appears to be talc being formed within the San Andreas fault. Overall, GPS and seismic station equipment acquisition and installation are slightly behind schedule. The Plate Boundary Observatory (PBO) has installed more than 500 permanent geodetic stations, 16 borehole strainmeter stations, and three long-baseline strainmeters. The USArray has installed more than 300 Transportable Array stations, and installations continue on schedule. Other highlights include the combined use of PBO geodetic and strain data and USArray seismic data in analyses of "slow earthquakes" in the Cascadia subduction system. The EarthScope project has been represented at several 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.

FY 2006 Milestones:

- San Andreas Fault site characterization studies carried out
- Installation of 530 equivalent permanent GPS and 54 equivalent borehole strain systems
- Complete installation of 3 long baseline strainmeters
- Equipment for 100 portable GS sites available
- Complete installation of 39 equivalent ANSS stations
- Installation of 281 equivalent Transportable Array stations
- Equipment for 1,200 Flexible Array sites available
- 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 728 equivalent permanent GPS and 85 equivalent borehole strain systems
- Complete first footprint of USArray (400 Transportable Array stations)
- Equipment for 1,680 Flexible Array sites available
- NSF conducts annual review of project status

FY 2008 Milestones:

- Redeployment of USArray/Transportable Array begins
- Main hole Phase 3 drilling and related activities completed at SAFOD
- Install monitoring instrumentation in main hole of SAFOD
- SAFOD data archiving and sample distribution completed
- Complete installation of 875 equivalent permanent GPS and 103 equivalent borehole strain systems
- Complete installation of 4 long baseline strainmeters
- Equipment for 2,400 Flexible Array sites available
- 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
- NSF conducts biennial reviews of project status

Funding Profile: Conceptual planning for the EarthScope project was 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	FY 2007 Request	Total
$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 2002 & Earlier	6.00						$6.00	-	**$6.00**
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				49.62	6.72		$6.72	$49.62	**$56.34**
FY 2007 Request				29.97	11.61		$11.61	$29.97	**$41.58**
FY 2008 Request					21.61		$21.61	-	**$21.61**
FY 2009 Estimate					24.00		$24.00	-	**$24.00**
FY 2010 Request					24.76		$24.76	-	**$24.76**
FY 2011 Estimate					25.82		$25.82	-	**$25.82**
FY 2012 Estimate					26.47		$26.47		
FY 2013 Estimate					27.00		$27.00	-	**$27.00**
Subtotal, R&RA	$9.36		-		$174.78		$184.14		
Subtotal, MREFC		-		$197.44		-		$197.44	
Total, Each Stage		**$9.36**		**$197.44**		**$174.78**			**$381.58**

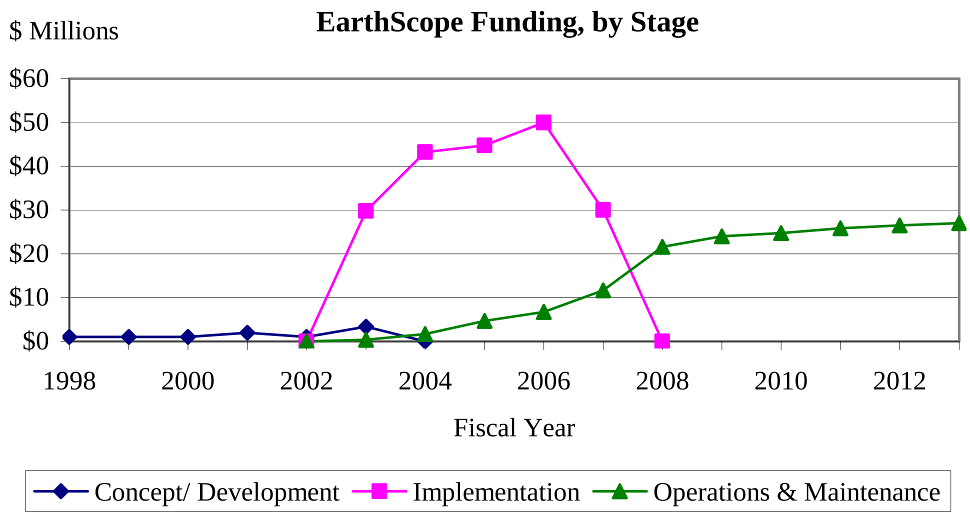
NOTE: The expected operational lifespan of this project is 15 years after construction is complete in FY 2008. Operations estimates for FY 2007 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

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.

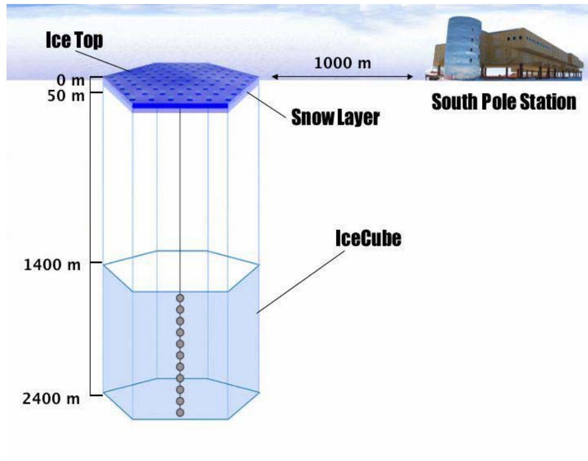


Future Science Support: Along with direct operations and maintenance support for the EarthScope Facility, NSF will support research performed utilizing the facility through ongoing research and education programs. The annual support for such activities is estimated to be about $15 million once the facility reaches full operations.

Recent Research Highlight

► **Tracking slow earthquakes:** In September 2005 and again in November 2006, the initiation and duration of a "slow earthquake", a newly recognized phenomenon, was tracked across the Puget Sound/Olympic Peninsula region of Washington using EarthScope geodetic, strain, and seismic data. "Slow earthquakes" release the energy of a moderate earthquake (approximately magnitude 6.5) across a region over several weeks, rather than in a single, rapid earthquake. These events occur below the locked source region of large subduction zone earthquakes, adding stress and bringing the large fault closer to failure. "Slow Earthquakes" in Cascadia appear to occur every 14.5 months (± 1 month), initiating beneath the Puget Sound and terminating beneath Vancouver Island. EarthScope instruments will continue to collect data in Cascadia and elsewhere along the plate boundary to be used to better understand the nucleation and duration of all types of earthquakes.

IceCube Neutrino Observatory



IceCube will occupy a volume of one cubic kilometer. One of the 80 strings of optical modules is depicted here (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*

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 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 Collaboration, 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; refurbishment and outfitting of the designated IceCube Laboratory at the South Pole; the actual drilling of the deep-ice holes, deployment of the needed DOMs, and their commissioning and verification; installation of a surface array of air shower detectors ('IceTop') to both calibrate and eliminate background events from the IceCube DOM array; construction of data acquisition, handling, archiving, and analysis systems; and associated personnel and logistics support.

Principal Scientific Goals: Measurement of the number, direction, timing, and energy spectrum of high-energy 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 dynamics underlying 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 South Pole environment. 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 standard NSF merit review.

Partnerships and Connections to Industry: The IceCube Collaboration consists of 12 U.S. institutions and institutions in three other countries: Belgium, Germany, and Sweden. NSF's foreign parners are contributing approximately $32 million to the project, as well as a pro rata share of IceCube Maintenance and Operations based on the number of PhD level researchers. 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 awardee-level oversight of the project. IceCube, internal to the project, is managed by a Project Director and a Project Manager. NSF, internally, has appointed a Project Coordinator to manage and oversee the NSF award. NSF carried out a comprehensive external baseline review of the entire project (including cost, schedule, technical, and management) 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. Such annual reviews were held in May of 2005 and 2006. Besides annual progress reviews and other specialized reviews (e.g., a safety review), 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 the OPP; support for operations, research, education, and outreach will be shared by OPP and MPS as well as other organizations and international partners.

Current Project Status: The project is proceeding according to plans and is on budget. Of the planned 70 DOM strings that will comprise IceCube, nine were deployed during the FY 2005 and 2006 drilling and deployment seasons at the South Pole, with an additional 12 strings planned for FY 2007. The Enhanced Hot Water Drill used to melt the 2.5 km water columns, into which the strings of DOMs are deployed, continues to perform well, with fuel efficiency better than planned and with a penetration rate that meets specifications. Of the DOMs deployed thus far, 99 percent are now working at or better than design specifications, consistent with original reliability requirements for the project. The data acquisition system (DAQ) and all related electronics have been transferred from the temporary counting house to the permanent IceCube Laboratory (ICL). All surface cables have also been moved and reconnected to the ICL, and DOM string commissioning activities are again being carried out. Installation of the IceTop surface array is proceeding according to schedule, with elements deployed on the surface at each of 26 string locations. DOM production and cold-testing facilities in the U.S. and Europe continue to work with high efficiency, producing reliable DOMs that continue to meet or exceed requirements. Key to the success of IceCube is the important logistics support chain required to transport all material and personnel to the South Pole, and this, too, continues to perform at a very high level.

Major milestones for IceCube are below:

FY 2007 Milestones (as of the submission date, the project is on schedule to meet projected goals):

- Complete ICL to conditional occupancy, and transition surface electronics, DAQ, and data handling systems from temporary counting house to ICL;

Produce and test DOMs, IceTop modules, cables, and associated electronics production to provide for 2007/2008 drilling and deployment season;
Drill, deploy, test, and commission 12 additional DOM strings and corresponding electronics and DAQ elements; this will make a total of 21 strings deployed, or 30 percent of the planned array;
Deploy 20 additional IceTop modules, including electronics and associated DAQ elements.
Complete full functionality of DAQ; and
Start limited operations for science.

Projected outyear milestones (FY 2008-2011) 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 2008-11 Milestones:
Completion, commissioning, and final acceptance of ICL;
Continue DOM and IceTop module production and testing through full amount planned;
Continue to drill, deploy, test, and commission DOM strings (up to 14 strings per season) and the corresponding IceTop modules (two for each DOM string), including installing and testing of the associated DAQ elements;
Complete installation and commissioning of strings; and
Ramp up to full operations of IceCube in FY 2011.

<u>Funding Profile</u>: Startup activities were funded with FY 2002-03 appropriations, and construction was initiated with FY 2004 appropriations. The current project cost is $274.12 million, $2.97 million more than the original estimate, but NSF's contribution remains constant at $242.07 million. The change is due to an increase in the value of the contributions made by foreign partners (now $32.05 million).

Appropriated and Requested MREFC Funds for IceCube
(Dollars in Millions)

FY 2004 & Earlier	FY 2005	FY 2006	FY 2007 Request	FY 2008 Request	FY 2009	FY 2010	Total
$81.29	$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. Neither table includes contributions from foreign partners.

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 Actual				56.44			-	$56.44	**$56.44**
FY 2007 Request				28.65	0.50		$0.50	$28.65	**$29.15**
FY 2008 Request				22.38	3.00		$3.00	$22.38	**$25.38**
FY 2009 Estimate				11.33	4.00		$4.00	$11.33	**$15.33**
FY 2010 Estimate				0.94	4.50		$4.50	$0.94	**$5.44**
FY 2011 Estimate					5.00		$5.00	-	**$5.00**
FY 2012 Estimate					5.13		$5.13		
FY 2013 Estimate					5.25		$5.25	-	**$5.25**
Subtotal, R&RA	$0.50		-		$27.38		$27.88		
Subtotal, MREFC		-		$242.07		-		$242.07	
Total, Each Stage		**$0.50**		**$242.07**		**$27.38**			**$269.95**

NOTE: The expected operational lifespan of this project is 25 years. Operations and Maintenance in support of scientific research will likely begin in FY 2007. Corresponding support for conduct of research also must be provided. International partners will provide a significant share of the operations and maintenance costs. Out-year budgets for O&M (FY2009-2013) are estimates only; actual budgets will be determined following a period of early limited operation (FY2007-2008), after which a comprehensive review and evaluation will take place. Host Laboratory responsibilities are covered by Antarctic Infrastructure and Logistics.

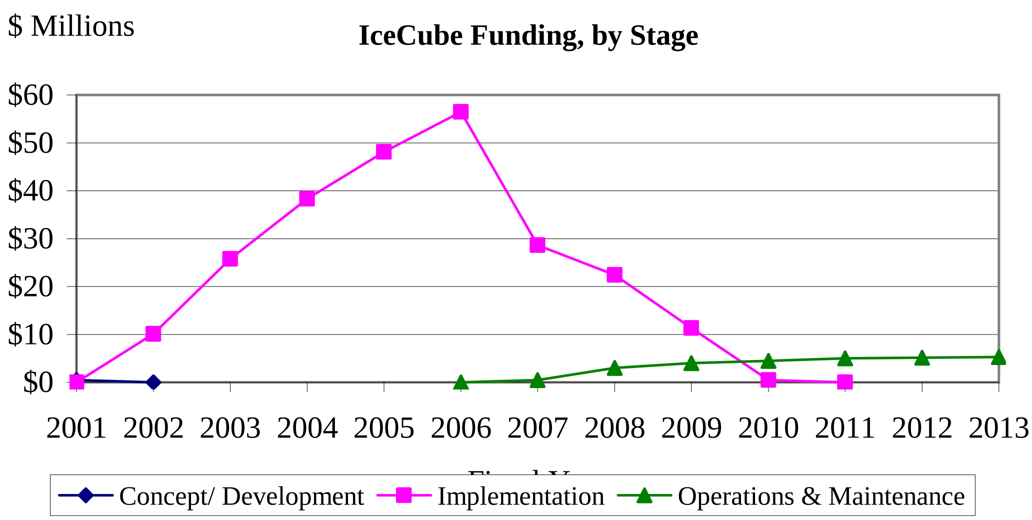
Information pertaining to the data in the table is provided below.

- Concept/Development: $500,000 was provided in FY 2001 through the R&RA account to support drill conceptual development and design; research and development (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 current project cost is $274.12 million, $2.97 million more than the original estimate. The change is due to an increase in the value of the contributions made by foreign partners (now $32.05 million). NSF's cost remains at $242.07 million.

  Construction is planned to extend into FY 2011, although funding will end in FY 2010. A comprehensive baseline review of IceCube was conducted in February 2004, providing a solid project baseline scope, cost, and schedule. Holes will be drilled and DOM strings deployed 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. The latter test validated the current drilling and deployment plan for project outyears to deploy 14 strings/season. Subject to weather-induced complications of logistics support, the full complement of DOMs should be in place by the end of FY 2011.

- Operations and Maintenance: Full operation of the IceCube Neutrino Observatory is planned to commence in FY 2011 following completion of drilling and DOM deployment in that year. Operations in support of scientific research may 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. The cost of the data analysis that will be carried out by the collaborating U.S. and foreign IceCube institutions, is estimated to be approximately $4.0 million and is outside of support for operations and maintenance (e.g., the data acquisition and data handling systems, data quality monitoring, information technology (IT) upgrades). 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 South Pole Station operations. The expected operational lifespan of this project is 25 years beginning FY 2011.



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 activities will come from the R&RA account. Annual education and outreach budgets are estimated at $400,000.

Future Science Support: 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 currently estimated at approximately $4.0 million once the facility reaches full operations.

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, and remote sensing will be linked via the internet to computational, analytical, and modeling capabilities to comprise NEON.

Principal Scientific Goals: NEON will advance ecological research by enabling studies of the biosphere at regional to continental scales, quantifying the 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 transformative 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 make comprehensive, regional to continental-scale observations 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 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.

Partnerships and Connections to Industry: Federal agencies such as the U.S. Geological Survey (USGS), the Environmental Protection Agency (EPA), and the Department of Energy (DOE) participated in the NEON Advisory Board and planning committees. A NEON Federal Agency Coordinating Committee meets on a regular basis[7]. Discussions are underway with the U.S. Department of Agriculture (USDA), National Park Service (NPS), USGS, and DOE on formal agreements. NEON will be the only observation network that will be able to provide the *in situ* biospheric component called for in the U.S. Group on Earth Observations Ten-year Strategic Plan. International perspectives are provided through the Global Lakes Ecological Observatory Network (GLEON) with Australia, New Zealand, Taiwan, China, South Korea, U.K., Finland, Sweden, Israel, and Canada. GLEON is a cyberinfrastructure and sensor prototype for NEON that focuses on lake metabolism. Private foundations, e.g., the Heinz Center, Nature Serve, and U.S. Landtrust, are participating in the NEON design and research and development. 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 require technological innovations that involve partnerships with industry for infrastructure development, deployment, and operation.

Management and Oversight: The Division of Biological Infrastructure (DBI) within the Directorate for Biological Sciences (BIO) provides oversight for the development, construction, and implementation of

[7] A full list of the members of these committees can be provided on request.

NEON. The NEON program officer, in consultation with a BIO-NEON committee, which includes the BFA DDLFP, formulates the program planning of NEON, i.e., drafting, release, and review of program solicitations, etc. The BIO Advisory Committee provides external advice to BIO about specific program planning aspects of NEON.

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), OOI, and Global Environment for Network Investigations (GENI). 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 U.S. 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 2006, a research community Consortium (NEON Inc.), which provides a link between NEON planning and construction, was established. The NEON Integrated Science and Education Plan and Networking and Informatics plans were merit reviewed. The preliminary Project Execution Plan (PEP), and Project Development Plan (PDP) were submitted for review. Research and development on environmental sensors, networks, and cyber tools that advanced the development of NEON as a network of nationally deployed infrastructure was supported through the R&RA account. R&RA funds were also provided to the Consortium of Regional Ecological Observatories to evaluate deployment criteria and locations across the continental U.S., Alaska, Hawaii, and Puerto Rico and to form the collaborations, partnerships, and organizations needed for NEON infrastructure deployment.

A Conceptual Design Review was held in November 2006. The review panel concluded that "NEON has made impressive progress in engaging the ecological community, in defining representative NEON domains across the continent, and in creating a vision for a continental-scale environmental biology capability. NEON has defined site-independent domain systems of fixed and movable sensors, with associated remote and mobile sensing, biotic data gathering and cyberinfrastructure. An integrated science plan illustrates how this system may be used to address NEON science questions. NEON has defined a governance process for the construction and operations phases. First cost estimates and preliminary schedules have been developed." The review panel also recommended that, led by the new Chief Executive Officer, NEON should prepare for a Preliminary Design Review (PDR) (planned for May 2007) and outlined the steps needed to achieve this goal.

Persistent sensing, sentinel measurements, remote sensing campaigns, satellite images, and legacy data will be connected and enabled via cyberinfrastructure into a national research platform. *Credit: Nicolle Rager-Fuller,NSF*

In FY 2006, R&RA funding was provided to NEON 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 expanded NEON research and development to include a cyberinfrastructure research program to address interoperability with other networks and observing systems.

During FY 2007, R&RA funds will be used to complete the final PEP for NEON, address specific site deployment, support NEON office activities, and begin work on Environmental Impact Assessments and/or Environmental Impact Statements (EIA/EIS). R&RA funds will also continue to support ongoing R&D projects such as environmental sensors and networks, cyberinfrastructure for environmental observatories, and enabling technologies for ecological forecasting. Following successful reviews as specified in NSF's Guidelines for Planning and Managing the MREFC Account, FY 2007 MREFC funds will be used for the construction and evaluation of the integrated NEON fundamental sensor infrastructure and cyberinfrastructure backbone, focusing on the NEON Fundamental Instrument Unit (FIU) Sensor Array Integration, the Cyberinfrastructure Network Integration, and Software Development to create an end to end observation system.

In FY 2008, NEON R&RA funds will be used to complete site deployment assessments and selection, EA/EIS studies (as appropriate); NEON project office costs prior to initiation of construction (if construction is delayed in FY 2007 or until late in FY 2008), and ongoing R&D projects on environmental sensors and networks, cyberinfrastructure for environmental observatories, and enabling technologies for ecological forecasting. MREFC funds are requested for the NEON Construction Office, Project Management Control System, and to begin mass construction of the NEON Fundamental Instrumentation Unit and embedded cyberinfrastructure and network level cyberinfrastructure.

Major milestones for NEON are listed below.

FY 2006 Milestones:
- NEON Inc. established
- NEON Science Plan and Requirements merit review completed
- Baseline Networking and Informatics Plan and an external design review completed
- NEON Conceptual Design, Preliminary PEP, and PDP completed
- Management review of the NEON Design Consortium and Project Office completed
- R&D of cyberinfrastructure to address interoperability with other environmental networks and observing systems funded

FY 2007 Milestones:
- NEON Conceptual Design Review (CDR) conducted in November 2006
- NEON infrastructure deployment plan to be finalized
- Final PEP to be completed
- NEON Preliminary Design Review (PDR) to be conducted in May 2007
- EIA/EIS will begin
- NEON fundamental technology unit (BioMesoNet, sensor micronets, and enabling cyberinfrastructure) will be assembled and integrated
- NEON Construction Project Office will start-up
- R&D projects on environmental sensors and sensor networks, cyberinfrastructure, and enabling technologies for ecological forecasting and social science collaboration continue

FY 2008 Milestones:
- Finalize national infrastructure deployment locations

Complete EIA/EIS, if appropriate,
Fully integrate and validate NEON fundamental technology unit (BioMesoNet, sensor micronets, and enabling cyberinfrastructure) and cyberinfrastructure
Initiate deployment of BioMesoNet and basic towers
Bring Project Management Control Software System to a fully operational status
Complete R&D projects on environmental sensors and sensor networks, cyberinfrastructure, and enabling technologies for ecological forecasting and social science collaboration

FY 2009 – FY 2013 Milestones:
Continue construction of NEON research, networking, informatics, and education, training, and outreach infrastructure
Support operations and research activities as NEON components are commissioned and come on-line

Funding Profile: The NEON baseline is under revision based on the continential design recommended in the NRC report. The revised baseline will be reviewed as part of the PDR scheduled for May 2007. The figures shown here reflect the FY 2007 Request. The revised baseline is expected to include higher funding levels in FY 2009 and in the out years. After this 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	FY 2012	Total
$4.00	$8.00	$20.00	$30.00	$26.00	$12.00	$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 2004 & Earlier	5.83						$5.83	-	**$5.83**
FY 2005	5.98						$5.98	-	**$5.98**
FY 2006 Actual	6.04						$6.04	-	**$6.04**
FY 2007 Request	11.94			4.00			$11.94	$4.00	**$15.94**
FY 2008 Estimate	15.94			8.00			$15.94	$8.00	**$23.94**
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			12.00	28.70		$30.70	$12.00	**$42.70**
FY 2013 Estimate	-				28.70		$28.70	-	**$28.70**
Subtotal, R&RA	$65.73		-		$109.00		$174.73		
Subtotal, MREFC		-		$100.00		-		$100.00	
Total, Each Stage		**$65.73**		**$100.00**		**$109.00**			**$274.73**

NOTE: The expected operational lifespan of this project is 30 years after construction is complete. Implementation funding levels will be updated when the Preliminary Design Review is complete (see information below). Annual operations and maintenance estimates for FY 2009 and beyond are presented strictly for planning purposes. They will be updated as new information becomes available.

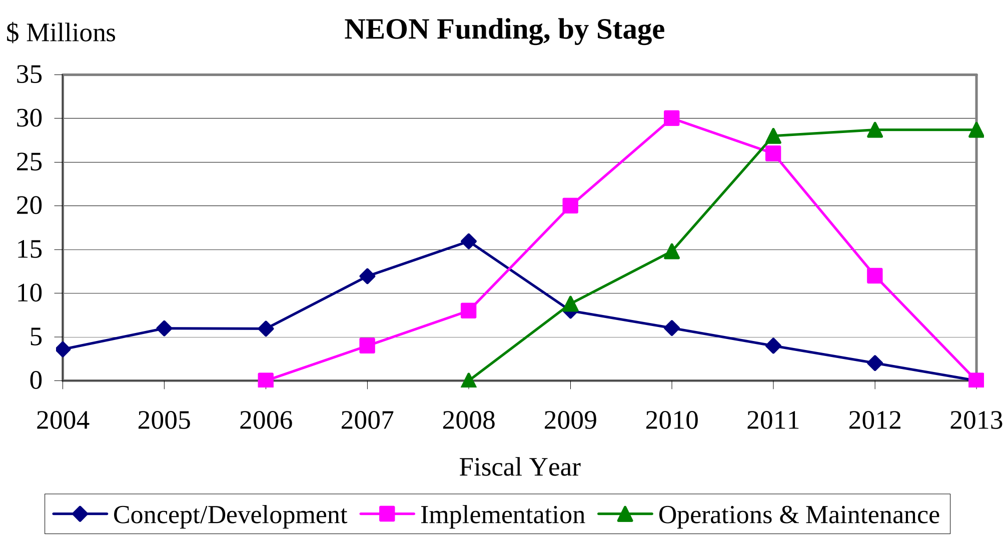
Information pertaining to the data in the table is provided below.

NOTE: The NEON baseline is under revision based on the continental design recommended in the NRC report. The revised baseline will be reviewed as part of the PDR review scheduled for May 2007. The figures shown here reflect the FY 2007 Request. The revised baseline is expected to include higher funding levels in FY 2009 and in the outyears.

- 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 U.S. 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 PEP for simultaneous national deployment. In FY 2006, the NEON Science Plan and Requirements, the Networking and Informatics Plan, preliminary PEP, PDP, and Construction Costs were completed. Support will be continued for ongoing R&D projects on enabling technologies.

- Implementation: Construction costs for NEON research, networking, and education infrastructure will be vetted at the PDR in May 2007. After a thorough cost review, a revised budget for NEON infrastructure and operations and maintenance 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 begin to establish the NEON Construction Office and assemble and evaluate the NEON fundamental technology unit (BioMesoNet, sensor micronets, and enabling cyberinfrastructure) that will be deployed. In FY 2008, MREFC funds will be used to complete staffing and infrastructure for the NEON construction office and begin materials acquisition for large scale deployment of the NEON FIU and cyberinfrastructure.

- Operations and Maintenance: Initial operations support will begin in FY 2009 as the CI backbone components of NEON (networking and informatics infrastructure) are commissioned and brought on-line.



Future Science Support: Since NSF supports 63 percent of the fundamental environmental biology 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 will be. Along with direct operations and maintenance support for NEON, NSF will support research performed using the NEON platform through a special competition and through ongoing research and education programs. Based on prior experience with other new activities, BIO expects that within 3-5 years proposal submission to regular programs to use NEON will have grown sufficiently to negate the need for a special competition and resources dedicated to the competition will be transferred to core programs.

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 the NEON data, information and research products will be fully accessible via the Internet.

Associated Research and Education Activities: During the design and planning stage, NEON strategic R&D has focused on reducing project risk by funding scientists and engineers to pursue research in the areas of cyberinfrastructure (e.g. prototyping for environmental observatories, embedded, scalability), sensor prototyping (aquatic genosensor, animal tracking, harsh environments), dynamically drive data analysis, end-to-end cyberinfrastructure design of the NEON fundamental instrument unit, and software development for field and data hand held devices. In addition to training graduate students, these research projects included undergraduate participation through funding from the Research Experiences for Undergraduates Program. Outreach conducted by these individual projects includes K-12 students, teachers, and the public. As an example, during engineering week over 600 K-12 students, from elementary school to senior high school students around Missouri, along with their teachers, visited an engineering lab focused on developing animal video sensing. Workshops were conducted in the areas of social science, modeling, and animal sensing. These workshops focused on evolving technologies, technical and development issues, fostering collaborations, enhancing interoperability among observing systems, and communication. Active outreach to and involvement by minority serving institutions was initiated through the establishment of a NEON mentorship program by the Science and Engineering Alliance. The program involves Historically Black Colleges (HBCUs), Hispanic Serving Institutions (HSIs) and Tribal Colleges and Universities (TCUs).

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. A cutting edge, user-enabling cyberinfrastructure will link the three components of the OOI and facilitate experimentation using assets from the entire OOI network. The observatory infrastructure of the OOI will be operated as a shared-use facility with open community access to data.

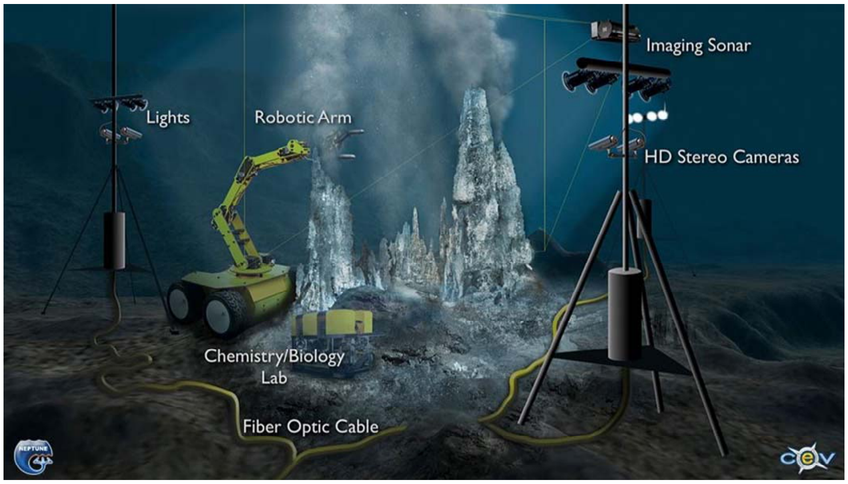
Principal Scientific Goals: Scientific problems requiring OOI infrastructure are broad in scope and encompass nearly every area of ocean science. Once established, seafloor observatories will provide earth, atmospheric, and ocean scientists with unique opportunities to study multiple, interrelated processes 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.

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 the Division of Ocean Sciences (OCE) 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 were involved in drafting the OOI Conceptual Network Design (CND) as well as in the review of OOI planning. Industry will also be important participants in the construction and implementation phase of the OOI as well as in the future development of sensors critical to the evolution of the OOI network.

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 PAT that includes representatives from GEO, BIO, ENG; BFA; OISE; OGC; and OLPA. The BFA DDLFP 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 external advisory structure consisting of executive, scientific, and technical advisory committees. Advisory committee membership will be drawn from individuals with expertise in ocean observing science and engineering. Requests for Proposals have been released by the Project Office to establish Implementing Organizations (IOs) that 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 (NOAA), the U.S. Navy, the National Aeronautics and Space Administration (NASA), and the U.S. Coast Guard.



Conceptual representation of a future seafloor laboratory on the Regional Cabled Observatory network. *Credit: the NEPTUNE Project* www.neptune.washington.edu

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. In 2005, detailed conceptual proposals for ocean science research experiments were solicited through the Project Office. These proposals were peer reviewed and used to develop the OOI CND and to identify specific experimental instrumentation needs of the user community. From these proposals, detailed cost estimates for infrastructure to be constructed though the OOI have been developed. The initial CND arising from this exercise was reviewed and discussed by approximately 300 members of the ocean science community at the March 2006 OOI Design and Implementation workshop. Input from this activity was incorporated into the network design that was reviewed at the OOI Conceptual Design Review (August 14-17th 2006) as well as by the "Blue Ribbon" panel (July 2006), which reviewed whether the science that will be enabled by the OOI network is of highest priority for the ocean science research community. Recommendations from these reviews were incorporated into the final CND plan that will be reviewed at the Preliminary Design Review (PDR) in December of 2007. 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:
- Internal Management Plan reviewed by Facilities Panel
- Completion of Project Development Plan
- OOI Conceptual Design Review

FY 2007 Milestones:
- Selection of Implementing Organizations
- OOI Preliminary Design Review and Construction Proposal Review
- Development of Programmatic Environmental Assessment
- Initial RCO cable route surveys
- Release of RFP for deployment of the RCO

FY 2008 Milestones:
- Shore station construction for the RCO
- Award of RFP for deployment of the RCO
- Finalize RCO cable route surveys
- Initial implementation of OOI cyberinfrastructure
- EA/EIS permitting process for the RCO cable route and coastal array

FY 2009 Milestones:
- Initiate first phase of the global array
- Initiate first phase of the coastal array
- Continue deployment of the Regional Cabled Network
- Initial installation and inspection of cable backbone section
- Initial installation of science nodes and instrumentation on backbone section
- Build 1.0 of the OOI cyberinfrastructure
- Initial implementation of the OOI Education and Public Awareness Plan

FY 2010 Milestones:
- Continue first phase of the global array
- Continue first phase of the coastal array
- Continue deployment of the Regional Cabled Network
- Final installation and inspection of cable backbone section
- Final installation of science nodes and instrumentation on backbone section
- Build 2.0 of the OOI cyberinfrastructure
- Continued implementation of the OOI Education and Public Awareness Plan

FY 2011 Milestones:
- Second phase of the global array
- Second phase of the coastal array
- Commissioning and testing of the RCO
- Build 3.0 of the OOI cyberinfrastructure
- Finalize implementation of the OOI Education and Public Awareness Plan

FY 2012 Milestones:
- Complete second phase of the global array
- Complete second phase of the coastal array

Commissioning and testing of the global and coastal arrays
Commissioning of the OOI cyberinfrastructure

Funding Profile: NSF expects to spend approximately $61 million in concept and development activities through FY 2007. The total construction cost for OOI is $331.11 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 Request	FY 2009	FY 2010	FY 2011	FY 2012	Total
$5.12	$30.99	$80.00	$90.00	$95.00	$30.00	$331.11

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	4.15						$4.15	-	$4.15
FY 2007 Request	8.30			5.12			$8.30	$5.12	$13.42
FY 2008 Request	9.00			30.99	6.10		$15.10	$30.99	$46.09
FY 2009 Estimate				80.00	10.20		$10.20	$80.00	$90.20
FY 2010 Estimate				90.00	15.20		$15.20	$90.00	$105.20
FY 2011 Estimate				95.00	29.30		$29.30	$95.00	$124.30
FY 2012 Estimate				30.00	46.40		$46.40	$30.00	$76.40
FY 2013 Estimate					50.00		$50.00	-	$50.00
FY 2014 Estimate					53.00		$53.00	-	$53.00
Subtotal, R&RA	$60.37		-		$210.20		$270.57		
Subtotal, MREFC		-		$331.11		-		$331.11	
Total, Each Stage		$60.37		$331.11		$210.20			$601.68

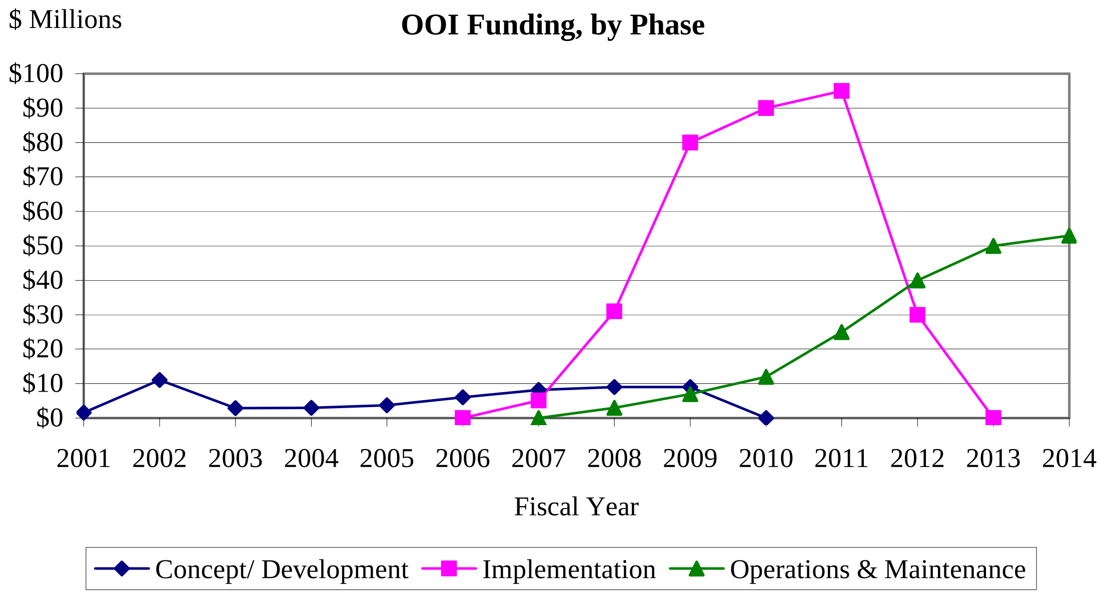
NOTE: A steady state of about $50.0 million in operations support is expected to occur in or about FY 2013. The expected operational lifespan of this project is 30 years, beginning in FY 2011. Operations estimates for FY 2008 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

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

- Concept/Development: NSF provides nearly $45 million in R&RA funding through FY 2006, and an additional $17.30 million in FY 2007 and FY 2008, to support development activities to ensure that technologies needed for OOI implementation are ready by the Construction Phase. These funds also support 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. In addition, $11.60 million was awarded to the Monterey Bay Aquarium Research Institute 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. Finally, an office has been established to coordinate and lead development activities for the OOI.

- 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.



Associated Research and Education Activities: Research activities utilizing OOI infrastructure will be selected through the standard OCE, peer-review proposal process to ensure that experiments are of the highest caliber and that they are closely linked to programmatic priorities within the Division of Ocean Sciences. Collaboration with other environmental research programs such as the Integrated Ocean Drilling Program and the National Ecological Observing Network will encourage the implementation of a broad range of interdisciplinary experiments never before possible. These experiments will be catalysts for development of new fields of environmental study and will enhance education activities across a broad range of disciplines. Education and outreach activities will be enhanced through support of educators with expertise in utilizing large data systems to support education as well as in developing the tools targeted to meet the needs of identified audiences.

Future Science Support: Along with direct operations and maintenance support for the OOI, NSF will support research performed using this infrastructure through ongoing research and education programs. The annual support for such activities is estimated to be about $50.0 million, once the network is fully implemented.

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 ice-free ocean environments. The vessel will accommodate approximately 50 scientific and technical staff. The converted drillship will provide the U.S. facility contribution to the Integrated Ocean Drilling Program (IODP), which began in October 2003. The IODP is co-led by NSF and the Ministry of Education, Culture, Sport, Science and Technology (MEXT) of Japan. European and Asian nations are also participating in the program.

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, classroom modules on IODP research initiatives and outreach displays for museums and educational/teaching institutions will be developed through research awards.

NSF Management and Oversight: The project is managed and overseen by a project manager in the Division of Ocean Sciences in GEO. The project manager receives advice and oversight support from a NSF PAT, which consists of representatives from GEO, OPP, BFA, and OGC. The BFA DDLFP 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 includes 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 \$57.23 million appropriated in FY 2006. Engineering design and science lab development activities are currently underway. The project schedule is outlined below:

FY 2006 Milestones:
- Vessel Decision and Drilling Contractor Awarded
- Initiated Engineering Design Phase, including Science Lab Development

FY 2007 Milestones:
- 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
- Complete Equipment/Structural Removals

Develop Production Engineering Package
Complete Habitability and Science improvements
Outfit Scientific Laboratories
Vessel Acceptance Trials
Vessel Commissioning and Acceptance –Terminate SODV MREFC project
Vessel Scientific Operations Begin

<u>Funding Profile</u>: Planning through FY 2005 cost approximately $4.7 million, funded through the R&RA account. In FY 2005, $14.88 million was appropriated to begin the project; approximately $6.08 million of this amount was awarded to JOI to initiate contract activity, planning and design. Approximately $109.0 million of MREFC funds will be required from FY 2005 through FY 2007 for conversion/equipping/testing of the drillship.

Appropriated and Requested MREFC Funds for SODV

(Dollars in Millions)

FY 2005	FY 2006	FY 2007 Request	Total
14.88	$57.23	$42.88	$115.00

NOTE: Totals may not add due to rounding.

SODV Funding Profile

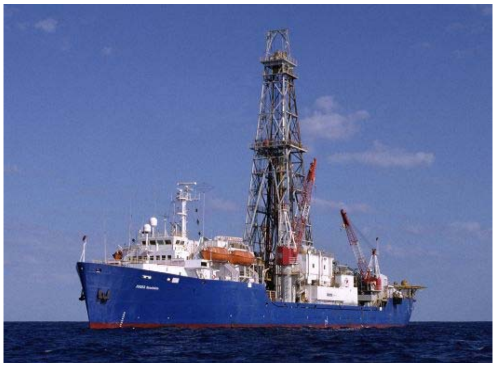
(Obligated Dollars and Estimates in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		**Grand Total**
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	
FY 2004 & Earlier	4.20						$4.20	-	$4.20
FY 2005	0.50			6.08			$0.50	$6.08	$6.58
FY 2006				66.03			-	$66.03	$66.03
FY 2007 Request				42.88	21.30		$21.30	$42.88	$64.18
FY 2008 Request					33.36		$33.36	-	$33.36
FY 2009 Estimate					35.03		$35.03	-	$35.03
FY 2010 Estimate					36.78		$36.78	-	$36.78
FY 2011 Estimate					38.62		$38.62	-	$38.62
FY 2012 Estimate					40.55		$40.55		
FY 2013 Estimate					42.58		$42.58	-	$42.58
Subtotal, R&RA	$4.70		-		$248.21		$252.91		
Subtotal, MREFC		-		$115.00		-		$115.00	
Total, Each Stage		$4.70		$115.00		$248.21			$367.91

NOTE: Totals may not add due to rounding.
A steady state of about $33 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. The ship conversion activity is currently out for bid. The budget estimates shown may be modified based on actual shipyard bids received for the conversion work.

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

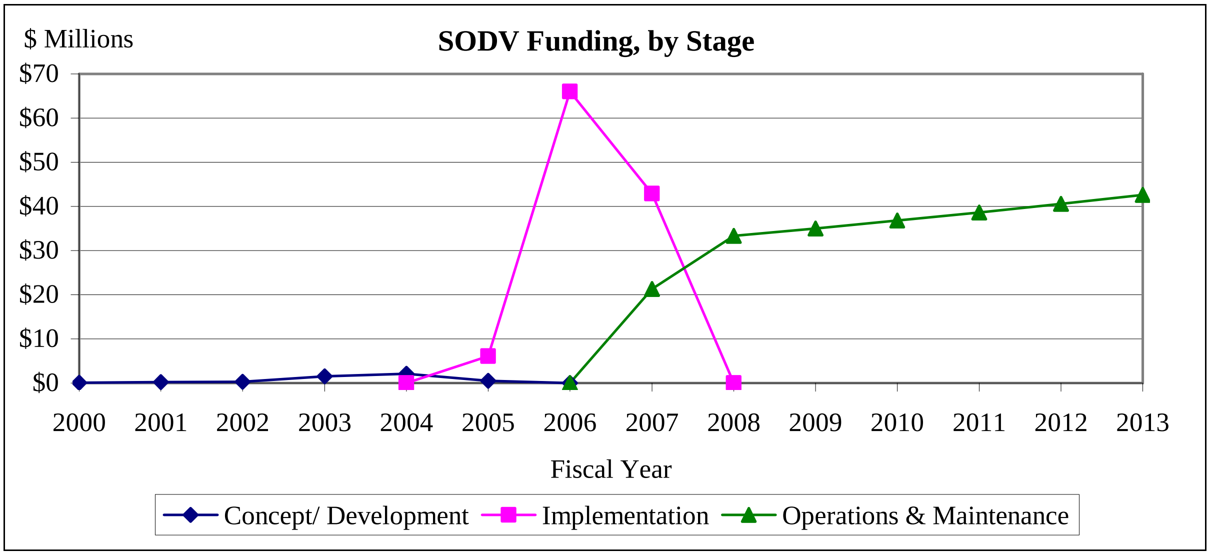
- Concept/Development: Activities supported by the R&RA account included coordination and planning efforts necessary for SODV planning with Japanese partners and the scientific user community; development of the SODV Project Execution Plan by the contractor; scoping of the environmental requirements, and permitting issues for the SODV drilling vessel.



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*

- Implementation: The MREFC funds in FY 2005-2007 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.



Associated Research and Educational Activities: Since this vessel will serve the IODP, the activities associated with research and education are described in the Facilities chapter.

Future Science Support: Along with direct operations and maintenance support for IODP, NSF will support research performed at the facility, through ongoing research and education programs. The annual support for such activities is estimated to be about $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 and Education Goals: The completed South Pole Station will provide a platform for the conduct of science at the South Pole and fulfills NSF's mandate to maintain a continuous U.S. presence at the South Pole in accordance with U.S. policy. NSF will also 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: 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 closely by the OPP Facilities Engineer and other OPP staff, and on a periodic basis by the project's PAT. The BFA DDLFP regularly briefs the CFO and the NSF Director on project status.

Early 2006 photograph of South Pole Station as it completes the renovation process.

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 FY 2007 budget requested $9.13 million to continue the project and noted the possibility that final completion might require additional funding. Following a full external review of the remaining scope of the project, conducted by a team of experts, OPP has prepared a revised SPSM project cost and schedule that takes into account several risk factors of concern to the review panel, such as competition for skilled construction workers with reconstruction activities in Iraq and post-Katrina Louisina and Alabama; weather uncertainties; and scientific projects competing for limited logistics capabilities. These and other risk factors were also incorporated into associated contingency funds and add $6.55 million to the project cost, bringing the total to $149.30 million. The revised schedule calls for the project to be completed in 2010. This delay does not impact full use of planned station facilities and is unlikely to cause significant cost increases.

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	FY10
Station Equipment	FY02/03	FY03/04	FY04/05	N/A	FY10

Funding Profile: Based on an updated project cost and schedule review completed after the 2005/2006 operating season, the estimated total cost to complete SPSM is $149.30 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	FY 2008 Request	Total
SPSM												
Appropriations	70.00	39.00	5.40	13.47	-	5.96	1.29	-	-	9.13	6.55	150.80
Reprogramming				-1.00	-0.50	-0.24			0.23			-1.51
	$70.00	$39.00	$5.40	$12.47	-$0.50	$5.73	$1.29	-	$0.23	$9.13	$6.55	$149.30

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, and $110,000 from other MREFC projects.

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 unusual logistics associated with construction in Antarctica 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 $133.48 million through FY 2006.

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 Actual[1]				13.07			-	$13.07	$13.07
FY 2007 Request				9.27	15.00		$15.00	$9.27	$24.27
FY 2008 Request				6.55	15.38		$15.38	$6.55	$21.93
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
FY 2013 Estimate							-	-	-
Subtotal, R&RA	$16.40		-		$95.74		$112.14		
Subtotal, MREFC		-		$149.30		-		$149.30	
Total, Each Stage		$16.40		$149.30		$95.74			$261.44

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.

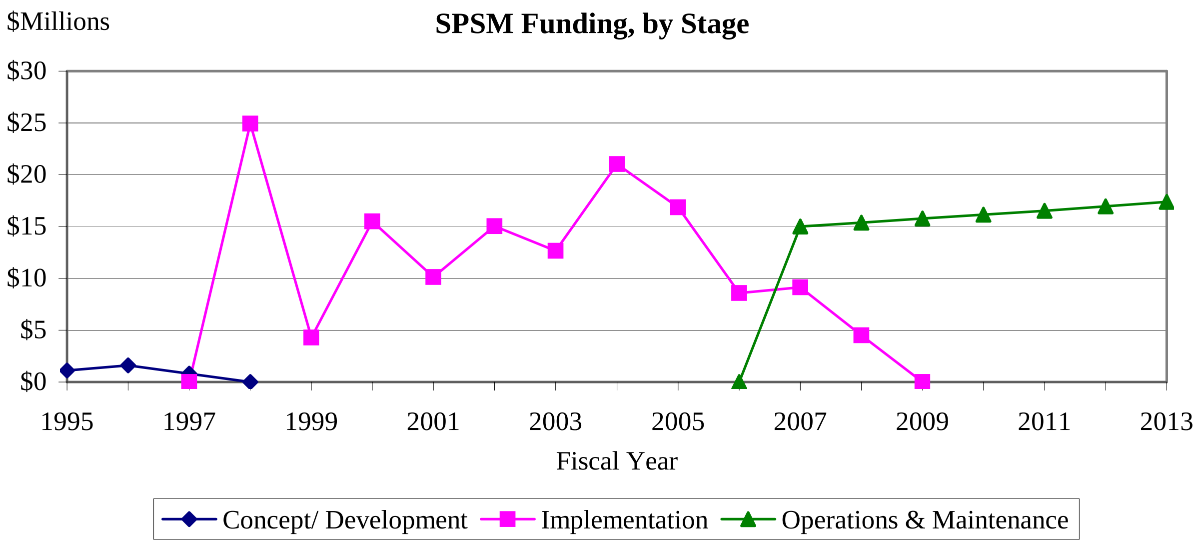
[1]FY 2007 implementation costs include carryover from FY 2006 into FY 2007.

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 2008. 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 $9.5 million.

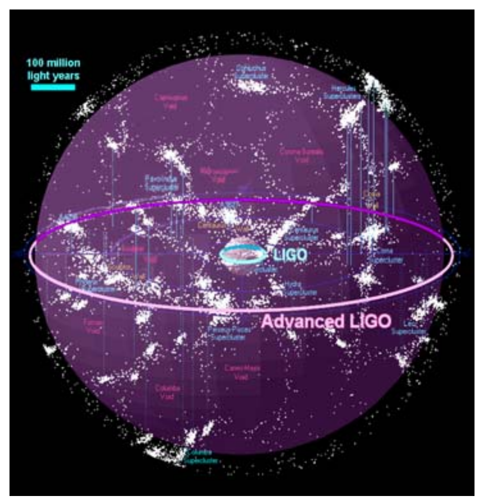
SECOND PRIORITY: NEW STARTS IN 2008

NSF's second priory 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 one new start in FY 2008: Advanced LIGO.

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) separated by 3,000 km[8]. 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 the lengths of the arms 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 ten 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 is in the process of achieving its objectives as planned and may detect the first gravitational waves. AdvLIGO will greatly increase the facility's sensitivity to ensure the detection of gravitational waves and to launch the new field of gravitational-wave astronomy.

The LIGO project was planned in two phases from the 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 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. Each small dot in the figure represents a galaxy. Credit: R. Powell,www.anzwers.org/free/universe/nearsc.html

The LIGO program has strongly stimulated interest in gravitational-wave research around the world, producing

[8] A full description of LIGO is included in the Facilities section of this document.

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.

<u>Principal Scientific Goals</u>: Einstein's theory of general relativity predicts that cataclysmic processes involving extremely 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, the universe is believed to be filled with gravitational waves from a host of cataclysmic cosmic phenomena; however, scientists have never directly detected a gravitational wave nor 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, and the Center was dedicated in early FY 2007.

<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 (PHY) within MPS, who also participates in the Physics Division 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 Project Leader for the AdvLIGO Project at the Massachusetts Institute of Technology (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 factor 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, currently operating at a sensitivity about 40 percent better than the design goal, began on November 4, 2005, and has a planned duration of eighteen months. The coincident duty factor – 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 currently 57% for S-5.

Current Status of AdvLIGO: 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. A baseline review in June 2006 judged that the project was ready for a construction start in FY 2008. 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 – 2008.

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 2009-2011 Milestones:
- Acquire components needed to begin installation in FY 2011-2012
- Prepare sites for installation

FY 2011-2012 Milestones:
- Shutdown Livingston interferometer (early FY 2011)
- Begin installation at Livingston (mid FY 2011)
- Shutdown Hanford interferometers (late FY 2011)
- Begin installation at Hanford (early FY 2012)

FY 2013-2014 Milestones:
- Begin final computer assembly and installation begins (mid FY 2013)
- Accept Livingston upgrade (early FY 2014)
- Accept Hanford upgrades (early to late FY 2014)

FY 2015 Milestones:
- Complete final computer assembly and installation
- Livingston and Hanford interferometers simultaneously operational
- Begin commissioning

Funding Profile:

Requested MREFC Funds for AdvLIGO
(Dollars in Millions)

FY 2008 Request	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Total
$32.75	$51.43	$46.30	$15.21	$23.73	$15.50	$19.78	$0.42	$205.12

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 Actual	9.70						$9.70		$9.70
FY 2007 Request	6.24						$6.24	-	$6.24
FY 2008 Request				32.75	28.20		$28.20	$32.75	$60.95
FY 2009 Estimate				51.43	27.60		$27.60	$51.43	$79.03
FY 2010 Estimate				46.30	27.80		$27.80	$46.30	$74.10
FY 2011 Estimate				15.21	29.20		$29.20	$15.21	$44.41
FY 2012 Estimate				23.73	32.20		$32.20	$23.73	$55.93
FY 2013 Estimate				15.50	36.00		$36.00	$15.50	$51.50
FY 2014 Estimate				19.78	42.90		$42.90	$19.78	$62.68
FY 2015 Estimate				0.42	47.90		$47.90	$0.42	$48.32
Subtotal, R&RA	$40.74		-		$271.80		$312.54		
Subtotal, MREFC		-		$205.12		-		$205.12	
Total, Each Stage		$40.74		$205.12		$271.80			$517.66

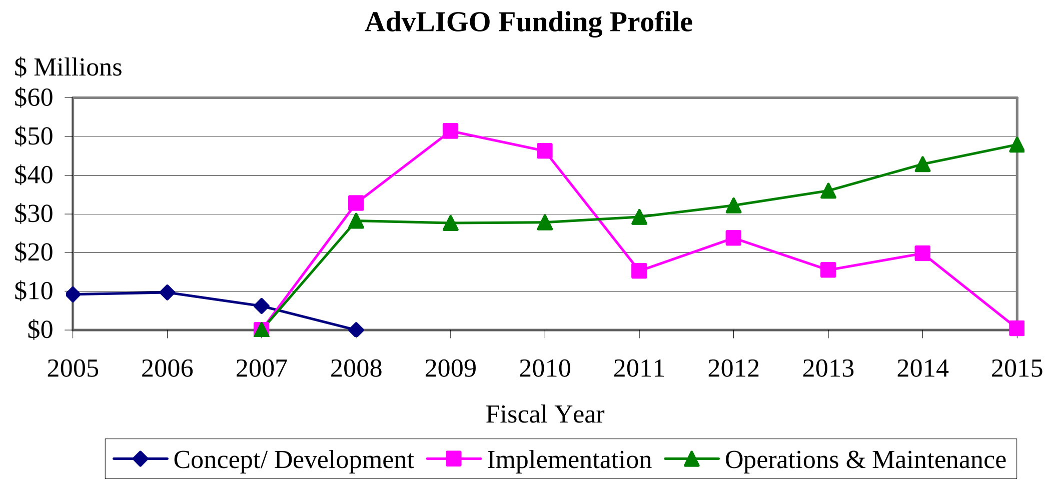
Note: Operations and Maintenance are for LIGO operations during AdvLIGO construction. Estimates for FY 2009 and beyond were developed strictly for planning purposes. A recent cost and schedule baseline review may result in modifications. R&RA funds for the period FY 2004 & Earlier through FY 2007 were in LIGO operations.

Detailed information pertaining to the data in the table is included below.

- Concept/Development: In the period of FY 2000 to FY 2008, $40.74 million will have been spent by the LIGO Laboratory for advanced R&D for concept development of AdvLIGO. Additional development work during the construction period will be directed to design development.

- Implementation: Funding during the 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.



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 at each site 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. In early FY 2007, the LIGO Science Education Center at the Livingston, LA site was dedicated and filled with Exploratorium exhibits. The Center 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.

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 LSC from universities through ongoing research and education programs. The annual support for such activities is estimated to be $5 million.

In 1997, LIGO founded the LSC to organize the major international groups doing research in support 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.

STEWARDSHIP

The NSF Strategic Plan for FY 2006-2011 defines the Stewardship strategic goal as supporting excellence in science and engineering research and education through a capable and responsible organization. Excellence in NSF's stewardship is essential to achieving the Foundation's mission and accomplishing its goals.

The activities that advance NSF's Stewardship goal are funded through five appropriations accounts. Additional details on each account are provided in the respective chapters.

Agency Operations and Award Management (AOAM): NSF proposes to change the name of the Salaries and Expenses account to Agency Operations and Award Management. AOAM increases by $3.77 million, or 1.3 percent, to $285.59 million in FY 2008. 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 approximately $490,000 million, or 4.1 percent, to $12.35 million in FY 2008. These resources include funding for personnel compensation and benefits, contract audits, training and operational travel, office supplies, materials, and equipment.

National Science Board (NSB) increases by approximately $120,000, or 3.1 percent, to $4.03 million in FY 2008. 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 14.30 million, or 4.1 percent, to $61.86 million in the FY 2008. Stewardship costs directly related to programs are funded within R&RA and EHR. Direct program Stewardship 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. This funding includes the request for Research.gov.

Stewardship by Appropriations Account
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Percent
Agency Operations and Award Management	$247.06	$281.82	$285.59	$3.77	1.3%
Office of Inspector General	11.47	11.86	12.35	0.49	4.1%
National Science Board	3.94	3.91	4.03	0.12	3.1%
R&RA Appropriation	47.24	42.29	52.42	10.13	24.0%
EHR Appropriation	6.11	9.65	9.44	-0.21	-2.2%
Subtotal, Program Support	53.35	51.94	61.86	9.92	19.1%
Total	$315.82	$349.53	$363.83	$14.30	4.1%

Totals may not add due to rounding.

NSF Workforce
Full-Time Equivalents (FTE)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
AOAM FTE Allocation					
Regular	*1,248*	*1,270*	*1,270*	-	-
Student	*35*	*35*	*35*	-	-
Subtotal, AOAM FTE Allocation	*1,283*	*1,305*	*1,305*	-	-
AOAM FTE Usage (Actual/Projected)					
NSF Regular	1,163	1,255	1,270	15	1.2%
NSF Student	32	35	40	5	14.3%
Subtotal, AOAM FTE[1]	1,195	1,290	1,310	20	1.6%
Office of the Inspector General[2]	63	63	63	-	-
National Science Board[3]	15	14	14	-	-
Arctic Research Commision[4]	4	4	4	-	-
Total, Federal Employees	1,277	1,371	1,391	20	1.5%
IPAs	135	170	170	-	-
Detailees to NSF	5	6	6	-	-
Contractors (est.)	318	376	430	54	14.4%
Total, Workforce	1,735	1,923	1,997	74	3.8%

[1]Additional information regarding FTEs funded through the AOAM appropriation are available in the AOAM 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]The U.S. Arctic Research Commission is described in a separate chapter.

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.

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 AOAM appropriation), although they continue to receive benefits through their home institutions, which are reimbursed by NSF.

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 organizes 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 Stewardship 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 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
IPA Costs	32.70	31.00	32.42	1.42	4.6%
Program Related Administration	20.65	20.94	29.44	8.50	40.6%
Total, Program Support Costs	$53.35	$51.94	$61.86	$9.92	19.1%

IPA Costs: 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 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
R&RA					
IPA Compensation	$23.95	$20.38	$21.56	$1.18	5.8%
IPA Lost Consultant & Per Diem	2.57	2.13	2.23	0.10	4.7%
IPA Travel	2.12	2.92	3.10	0.18	6.2%
Subtotal, R&RA Costs	28.64	25.43	26.89	1.46	5.7%
EHR					
IPA Compensation	3.24	4.35	4.31	-0.04	-0.9%
IPA Lost Consultant & Per Diem	0.50	0.85	0.84	-0.01	-1.2%
IPA Travel	0.32	0.37	0.38	0.01	2.7%
Subtotal, EHR Costs	4.06	5.57	5.53	-0.04	-0.7%
Total, IPA Costs	$32.70	$31.00	$32.42	$1.42	4.6%

Totals may not add due to rounding.

Program Related Administration includes funding for certain Foundation-wide activities such as major studies, evaluations, outreach efforts, NSF contributions to interagency e-Government activities, and grants management applications that benefit the research community, such as a Reviewer Management System to more effectively plan for, and find, thousands of scientific experts required to support the merit review process. Additional information on the benefits of government-wide e-Government initiatives at NSF is included in the next section.

Also included is funding to enable NSF to leverage and align its plans for the next generation of FastLane with its new role as a Research Consortia Lead for the Grants Management Line of Business (GMLoB). The additional resources will be used to establish and provide a web portal, Research.gov, for research institutions to conduct grants business with Federal research agencies. $15.0 million is included in the request for Research.gov, a funding level that will enable the Foundation to phase-in the government-wide functionalities over several years.

E-Government Initiatives

The National Science Foundation (NSF) is providing funding contributions in FY 2007 and FY 2008 to the following government-wide E-Government Initiatives:

NSF FY 2007 Funding for E-Government Initiatives

				Appropriations Account		
Initiative	**FY 2008 Agency Contributions**	**FY 2008 Agency Svc. Fees**	**NSF Total**	**Salaries & Expenses**	**R&RA**	**EHR**
Grants.gov	$520,570		**$520,570**		$437,279	$83,291
Grants Management LoB	$60,147		**$60,147**		$50,523	$9,624
E-Authentication	$0		**$0**		$0	$0
E-Travel		$127,000	**$127,000**	$127,000		
Geospatial LoB	$15,000		**$15,000**		$12,600	$2,400
E-Training*		$370,000	**$370,000**	$370,000		
E-Rulemaking	$155,000		**$155,000**		$130,200	$24,800
Business Gateway	$68,394		**$68,394**		$57,451	$10,943
Recruitment One-Stop (USA Jobs)		$4,004	**$4,004**	$4,004		
E-HRI**		$17,600	**$17,600**	$17,600		
Integrated Acquisition Environment	$4,288		**$4,288**		$3,602	$686
Human Resources Management LoB	$65,217		**$65,217**		$54,782	$10,435
Financial Management LoB	$83,333		**$83,333**		$70,000	$13,333
Budget Formulation/Execution LoB	$75,000		**$75,000**		$63,000	$12,000
IT Infrastructure LoB	$20,000		**$20,000**		$16,800	$3,200
E-Payroll (incl. Shared Services)***		$327,895	**$327,895**	$327,895		
Total	$1,066,949	$846,499	**$1,913,448**	$846,499	$896,237	$170,712

Totals may not add due to rounding.

NSF FY 2008 Funding for E-Government Initiatives

Initiative	FY 2008 Agency Contributions	FY 2008 Agency Svc. Fees	NSF Total	Appropriations Account: Salaries & Expenses	Appropriations Account: R&RA	Appropriations Account: EHR
Grants.gov	$536,187		**$536,187**		$450,397	$85,790
Grants Management LoB	$174,360		**$174,360**		$146,462	$27,898
E-Authentication	$65,217		**$65,217**		$54,782	$10,435
E-Travel		$155,183	**$155,183**	$155,183		
Geospatial LoB	$15,450		**$15,450**		$12,978	$2,472
E-Training*		$370,000	**$370,000**	$370,000		
E-Rulemaking	$135,000		**$135,000**		$113,400	$21,600
Business Gateway	$22,000		**$22,000**		$18,480	$3,520
Recruitment One-Stop (USA Jobs)		$4,684	**$4,684**	$4,684		
E-HRI**		$52,000	**$52,000**	$52,000		
Integrated Acquisition Environment	$12,961		**$12,961**		$10,887	$2,074
Human Resources Management LoB	$65,217		**$65,217**		$54,782	$10,435
Financial Management LoB	$44,444		**$44,444**		$37,333	$7,111
Budget Formulation/Execution LoB	$85,000		**$85,000**		$71,400	$13,600
IT Infrastructure LoB	$20,000		**$20,000**		$16,800	$3,200
E-Payroll (incl. Shared Services)***		$327,895	**$327,895**	$327,895		
Total	$1,175,836	$909,762	**$2,085,598**	$909,762	$987,702	$188,134

Totals may not add due to rounding.

Benefits realized through the use of these initiatives are as follows:

- **Grants.gov**
  The Grants.gov Initiative benefits NSF and its grant programs by providing a single location to publish grant (funding) opportunities and application packages, and by providing a single site for the grants community to apply for grants using common forms, processes and systems. NSF will post all of its discretionary grants programs in Grants.gov Find and all of its funding opportunities in Grants.gov Apply beginning in FY07.

- **Grants Management Line of Business**
  This initiative benefits NSF by improving the delivery of services to grant recipients, improving decision-making, and decreasing costs associated with building and maintaining Grants Management IT systems. GM LoB identifies Federal Service Centers. These Service Centers work with customer agencies to define requirements, streamline processes, improve reporting, and host a grants management system. The grants management system can be used by multiple grant-making agencies to make awards. By sharing services, NSF's costs to build and maintain grants management systems decrease. NSF has been chosen as a consortia lead for grants made by the research community.

- **E-Authentication**
  The initiative benefits NSF by providing E-Authentication expertise, guidance, and documentation, including project planning and reporting templates, to enable NSF to achieve

production implementation of E-Authentication for aspects of its FastLane application. The E-Authentication Federation allows NSF to use identity credentials issued and managed by organizations within and outside the Federal Government, thereby relieving NSF of much of the cost of providing its own identity management solutions.

- **E-Travel**
  This web-based service benefits NSF by helping to minimize technology costs and guarantee refreshed functionality for travel management services. The end-to-end service will enable NSF to capture real time visibility into the buying choices of travelers and assist in optimizing travel budgets.

- **Geospatial Line of Business**
  NSF participates in activities related to the development of Geospatial Line of Business (GEO LoB) to ensure the effective and efficient provision of geospatial data to the research community.

  NSF is able to realize cost savings by not having to process individual requests for data in an ad-hoc fashion. The public frequently requests maps and other geospatial data from NSF, particularly during emergency response situations. The Geospatial portal provides an integrated environment to coordinate (and focus) these requests, making the agency's response more efficient. It has the potential to reduce the cost of supporting such data requests.

  NSF has had significant impact on the nation's research in the area of Geographic Information Systems. The National Center for Geographic Information and Analysis (NCGIA) centers at the University of California- Santa Barbara, the State University of New York at Buffalo, and the University of Maine-Orono have developed and demonstrated powerful practical applications of geospatial data and technology. The NSF Geographic and Regional Science Program sponsors research on the geographic distributions and interactions of human, physical, and biotic systems on the Earth's surface utilizing GIS at the State, county and city level. These research programs benefit from GOS as a resource for locating data and other geospatial resources for use in their studies.

- **E-Training**
  This initiative supports the development of NSF's workforce and advancing the accomplishment of its mission through simplified and one-stop access to e-Training products and services. Use of NSF's learning management system, AcademyLearn, will enhance the agency's ability to attract, retain, manage, and continuously educate its workforce.

- **E-Rulemaking**
  The Federal Docket Management System (FDMS) under the leadership of this initiative provides the research community a web-based, central location to track proposed regulations by NSF and to provide comment when applicable.

- **Business Gateway**
  The Business Gateway Initiative helps NSF in its goals of promoting science, advancing the national health, and securing the national defense by helping small businesses partner with NSF. NSF has a program called "NSF SBIR/STTR" whose purpose is to increase "the incentive and opportunity for small firms to undertake cutting-edge, high risk, high quality scientific, engineering, or science/engineering education research that would have a high potential economic payoff if the research is successful."

Additionally, the Business.gov website provides easy access to all of the NSF forms/instructions relevant to businesses. The site also provides compliance assistance for companies seeking to meet all of the regulatory requirements of NSF and other Federal agencies.

- **Recruitment One-Stop**
  NSF benefits through state-of-the-art online recruitment services to Federal job seekers including online job posting, intuitive job searching, resume warehousing, online application submission, automated eligibility and status feedback, applicant data mining and integration with sophisticated automated assessment tools.

- **Enhanced Human Resource Integration (EHRI)**
  This initiative is developing policies and tools to streamline and automate the electronic exchange of standardized human resource data (such as the electronic office personnel file) needed for creation of an official employee record. The EHRI tool set and central data repository will provide comprehensive knowledge management workforce analysis, forecasting, and reporting for the strategic management of human capital.

- **Integrated Acquisition Environment**
  Through adoption of the tools and services provided by IAE, NSF improves its ability to make informed and efficient purchasing decisions and allows it to replace manual processes. If NSF were not allowed to use the IAE systems, they would need to build and maintain separate systems to record vendor and contract information, and to post procurement opportunities. Agency purchasing officials would not have access to databases of important information from other agencies on vendor performance and could not use systems to replace paper-based and labor-intensive work efforts.

- **Human Resources Management Line of Business**
  NSF benefits through its use of best-in-class HR services and systems provided by one of the approved service providers. Through its adoption of an approved service provider, the agency can achieve the benefits of “best-in-class” HR solutions without the costs of developing and maintaining their own HR systems. Employees across the agency benefit from improved HR services.

- **Financial Management Line of Business**
  The initiative benefits NSF by providing the reference tools and templates needed to assist them in planning and managing their migration to a selected center of excellence. The FM LoB has established an Advisory Board to govern the activities and decision making process for the initiative. NSF’s involvement with this board affords them the opportunity to review critical issues that have an impact on their FM systems, voice their unique needs and concerns, and collaboratively offer recommendations and influence decisions on how best to implement the common solution. In the short term, NSF will be provided key tools such as an RFP framework and SLA guides to help them develop agency agreements with their selected service providers. In the long term, NSF will have the opportunity to play an active role in standardizing core FM business process and data elements. NSF’s involvement in this crucial task ensures their needs and requirements are addressed in the target FM LoB enterprise architecture supporting the FM LoB common solution. This work allows NSF to influence the future direction of financial management across the government from both an information technology and business process perspective.

- **Budget Formulation and Execution Line of Business**
This initiative enhances NSF budgeting capabilities by strengthening the Federal budgeting profession through a community of practice, establishing a clearinghouse for sharing best practices, improving tools for government-wide budget exercises and collaboration, and establishing standards for data, data exchange, and modularity that facilitate flexible solutions, sharing, and re-usability. The BF&E LoB has established a Task Force that governs LoB activities and makes decisions. NSF's involvement with the Task Force ensures that solutions developed by the BF&E LoB meet NSF's needs.

- **IT Infrastructure Line of Business**
The initiative benefits NSF by providing government-wide target service levels and infrastructure cost measurements to objectively evaluate NSF IT Infrastructure investments against standard government and industry averages. This will allow for objective evaluation of NSF IT Infrastructure performance in the areas of Desktop/Seat Mgt, Data Centers, and Voice/Data Networks and provide guidance to develop action plans for improvement through use of standard best practices, and where appropriate, use of consolidation, shared service providers, and aggregated purchase agreements. The goal is to reduce the total cost of commodity IT infrastructure while not degrading performance and service to NSF users.

- **E-Payroll**
NSF has migrated its payroll function to the Department of Interior (DOI) service center. We have seen good integration between payroll, human resource and finance functions as well as a high level of customer service from DOI.

Performance Highlights

NSF conducts a comprehensive assessment of Stewardship (formerly Organizational Excellence, OE) activities as part of its GPRA reporting activities. The Advisory Committee for GPRA Performance Assessment (AC/GPA) and the Advisory Committee for Business and Operations contributed to the assessment. These committees determined that NSF had demonstrated significant achievement in FY 2006 for the performance indicators associated with the OE goal. Those performance indicators were:

- Human Capital Management: develop a diverse capable, motivated staff that operates with efficiency and integrity.
- Technology-enabled Business Practices: utilize and sustain broad access to new and emerging technologies for business application.
- Performance Assessment: 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.
- Merit Review: operate a credible, efficient merit review system.

In the 2006 NSF Report to Employees, the Director and Deputy Director stated that NSF is recognized throughout the federal government as a leader for implementing outstanding results-oriented management practices and establishing collaborative partnerships with the scientific and federal communities. Among the accomplishments cited in this report are:

- NSF continues to maintain “Green” ratings for excellent management practices. NSF has sustained a “Green” rating for financial performance and e-Gov on the President’s Management Agenda (PMA) scorecard for over four years. In FY 2006, NSF was only one of three federal agencies to achieve four or more “Green” ratings in the five primary PMA initiatives. NSF has also achieved “Green” ratings for its two PMA programmatic initiatives of Eliminating Improper Payments and R&D Investment Criteria.

- NSF received its eighth consecutive unqualified “clean” audit opinion.

- In both the Department of Treasury’s Financial Management Service Scorecard and the CFO Council Metric Tracking System which tracks core financial metrics, NSF continued to have the most consistently high scores among all federal agencies.

- NSF is the only agency to receive the highest rating of “Effective” in all of its Program Assessment Rating Tool (PART) program evaluations from OMB.

- NSF received an “A” grade in the House Committee on Government Reforms study of 24 agencies’ security practices.

- After NSF co-chaired the Grants Management Line of business (GMLoB) task force, OMB selected NSF as one of the initial three consortia leads.

- NSF’s was awarded a Webby Award in a competition that Time Magazine calls the “online Oscars.” NSF’s website was named the “People’s Choice” among the best government websites.

- NSF’s *FY 2005 Performance Highlights* report received a League of American Communications Professionals (LACP) Honors Award at the 2005 Vision Awards. In a field of almost 2,000 entrants, NSF placed in the top 15 percent, and had the distinction of being the only federal government agency to be recognized for five years of distinction in its annual reports.

- NSF implemented AcademyLearn, a web-based learning management system to increase workforce productivity and aid in agency operations. AcademyLearn gives all employees access to approximately 2,000 professional and personal development online courses and provides proprietary e-business online tutorials.

AGENCY OPERATIONS AND AWARD MANAGEMENT $285,590,000

The FY 2008 Budget Request for Agency Operations and Award Management (AOAM) is $285.59 million, an increase of $3.77 million, or 1.3 percent, over the FY 2007 Request of $281.82 million. Adequate funding for Agency Operations and Award Management, particularly for staffing and information technology, is critical to the efficient operations of the agency.

Summary of Agency Operations and Award Management by Function
(Dollars in Millions)

	FY 2006 Actual[1]	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
Human Capital					
Personnel Compensation & Benefits	$153.21	$171.48	$182.29	$10.81	6.3%
Management of Human Capital	7.11	7.13	7.13	-	-
Operating Expenses	11.84	10.06	10.06	-	-
Travel	6.12	8.95	8.95	-	-
Subtotal, Human Capital	178.28	197.62	208.43	10.81	5.5%
Technology and Tools					
Information Technology	35.48	51.62	42.18	-9.44	-18.3%
Space Rental	20.81	23.88	26.28	2.40	10.1%
Other Infrastructure	9.99	8.70	8.70	-	-
Subtotal, Technology and Tools	66.28	84.20	77.16	-7.04	-8.4%
Business Analysis	2.50	-	-	-	N/A
Total, AOAM	$247.06	$281.82	$285.59	$3.77	1.3%

Totals may not add due to rounding.

[1]Includes $250K in appropriation transfer

AOAM NSF Workforce
(Full-Time Equivalent (FTE) and Other Staff)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
NSF AOAM-- Regular	1,163	1,270	1,270	-	-
NSF AOAM -- Student	32	35	40	5	14.3%
Subtotal, FTE Allocation	1,195	1,305	1,305	-	-
Detailees to NSF	5	6	6	-	-
Total, Workforce	1,200	1,311	1,311	-	-

NSF proposes to change the name of the *Salaries and Expenses* account to *Agency Operations and Award Management*. The proposed name is a straightforward description that reflects both the content of the activity and its overall purpose.

Appropriation Language

For agency operations and award management 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; $285,590,000: *Provided*, That contracts may be entered into under this heading in fiscal year 2008 for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year.

Agency Operations and Award Management
FY 2008 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Rescission	Carryover/ Recoveries	Transfers	Total Resources	Obligations Incurred/Est.
FY 2006 Appropriation	250.00	-3.19	-	0.25	247.06	247.06
FY 2007 Request	281.82	-	-	-	281.82	281.82
FY 2008 Request	285.59	-	-	-	285.59	285.59
$ Change from FY 2007						3.77
% Change from FY 2007						1.3%

Subtotals may not add due to rounding.

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

FY 2007 Request, AOAM……….………….…………………………………………………...........…$281.82

Human Capital +$10.81

Funding for Human Capital increases by $10.81 million to a total of $208.43 million, a 5.5 percent increase over the FY 2007 Request. The major component of this increased investment is:

- $182.29 million for Personnel Compensation and Benefits (PC&B), an increase of $10.81 million, which supports an increase in the usage of full-time equivalents (FTE) to the full FTE allocation sought in the FY 2007 Request. The increase also reflects the general pay raise, locality pay, and costs related to employee benefits.

Technology and Tools -$7.04

Funding for Technology and Tools is $77.16 million, which represents an decrease of $7.04 million, or -8.4 percent, over the FY 2007 Request. The major components of this investment are:

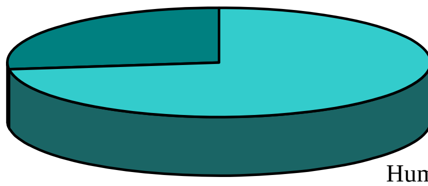
- $42.18 million for Information Technology (IT), a decrease of $9.44 million. The Request provides for basic maintenance for ongoing operations. To accommodate the reduced funding, NSF will delay implementation of new capabilities and planned investments for the NSF grants management applications.
- $26.28 million for Space Rental, an increase of $2.40 million over the FY 2007 Request. The increase is required to offset rapidly rising GSA rental costs, rising real estate taxes, increased utility costs, and to acquire additional leased space for roughly 25-30 additional staff.

Subtotal, Changes +$3.77

FY 2008 Request, AOAM.…………………………...……….………………………………........$285.59

AGENCY OPERATIONS AND AWARD MANAGEMENT – FY 2008 REQUEST BY MAJOR FUNCTION

FY 2008 AOAM Request of $285.59 Million



NSF is committed to supporting excellence in science and engineering research and education. In order for NSF to excel, the Foundation must have strong internal infrastructure and management process. To acknowledge this, the NSF Strategic Plan includes Stewardship as a strategic goal, on a par with the program related goals of Discovery, Learning, and Research Infrastructure. The Plan defines Stewardship as: "support excellence in science and engineering research and education through a capable and responsive organization."

The Plan includes a number of long-term priorities for the Stewardship goal. These emphasize improving transparency, consistency, and uniformity of the merit review process; continued emphasis on award oversight and management, particularly for large facilities; and implementing a range of activities to maintain and strengthen relationships with the agency's key stakeholders in the research and education community.

HUMAN CAPITAL ($208.43 million)

The FY 2008 request for Human Capital totals $208.43 million, an increase of $10.81 million, or 5.5 percent, over the FY 2007 Request of $197.62 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 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
Personnel Compensation and Benefits	$153.21	$171.48	$182.29	$10.81	6.3%
Management of Human Capital	7.11	7.13	7.13	-	-
Operating Expenses	11.57	10.06	10.06	-	-
Travel	6.39	8.95	8.95	-	-
Total, Human Capital	$178.28	$197.62	$208.43	$10.81	5.5%

Totals may not add due to rounding.

Personnel Compensation and Benefits ($182.29 million)

Personnel Compensation & Benefits

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount[3]	Change over FY 2007 Percent
Regular FTE Allocation	*1,248*	*1,270*	*1,270*		
Regular FTE Usage (actual/projected)	*1,163*	*1,255*	*1,270*	*15*	1.2%
Regular Salary					
Base Salary	$116.01	$128.65	$132.03	$3.38	2.6%
Salary Cost of Additional FTE	-	*6.97*	1.55		
Pay Increase & Locality Pay[1]	-	*2.06*	3.06		
Subtotal, Regular FTE Salary	$116.01	$128.65	$136.64	$7.99	6.2%
Student FTEs	*32*	*35*	*40*	*5*	14.3%
Student Salary	$0.96	$1.00	$1.22	$0.22	22.0%
Total, FTEs	*1,195*	*1,290*	*1,310*	*20*	*1.6%*
Subtotal, FTE Pay	$116.97	$129.65	$137.86	$8.21	6.3%
Benefits and Other Compensation[2]	$36.24	$41.83	$44.43	$2.60	6.2%
Total, PC&B	$153.21	$171.48	$182.29	$10.81	6.3%

[1]The increase includes the annualization of the FY 2007 pay raise and locality pay, nine months of the projected FY 2008 pay raise, as well as anticipated within grade and promotion increases.

[2]This category includes employee benefits, detailees to NSF, terminal leave, awards, and other benefits.

[3]The increase in the FY 2008 base salary reflects the full annual cost of employees hired throughout FY 2007.

The FY 2008 request for Personnel Compensation and Benefits is $182.29 million, an increase of $10.81 million, which fully funds 1,270 (FTE) employees and includes comparability and locality pay and costs related to employee benefits.

Management of Human Capital ($7.13 million)

The FY 2008 Management of Human Capital request is $7.13 million, equal to the FY 2007 request. Funding will be used for recruitment and retention activities targeting scientists, engineers, and educators who reflect the diversity of the communities served. Emphasis will be placed on the continued creation and implementation of policies designed to attract and retain high quality staff. Polices that will be reviewed and enhanced, as appropriate, include those governing marketing and assessment strategies, incentive programs, work flexibilities, and performance management practices. The new human capital policies will drive compensation practices that focus on hard-to-fill disciplines, and new programs which provide broader support to scientists and engineers employed from outside the metropolitan area.

NSF will also address succession planning, leadership, and employee development strategies to support improved supervisory and managerial education programs, with special emphasis on the rotational nature of many of its managerial personnel. FY 2008 funds will be used to comprehensively assess the content of its learning programs and the methodologies used to deliver them. Programs and technologies will be established to address essential skill gaps.

FY 2008 funds will continue to support workforce and staffing planning initiatives, required personnel security objectives, health unit and employee assistance services, provision of personnel processing and payroll services, and operational and strategic support to assist in the accomplishment of objectives in NSF’s Strategic Plan.

NSF will refine its human capital information infrastructure by continuing its efforts to implement fully interconnected capabilities, including robust analytics, skill gap assessment tools, interactive workforce planning and forecasting tools. The 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, and augment the curricula, content, and knowledge management portfolio of NSF’s Academy. Therefore, in addition to funds spent on the human capital program improvements**,** $2.26 million is requested in the Technology and Tools section of the Agency Operations and Award Management (AOAM) account to analyze and obtain human resource information systems and to provide the IT infrastructure necessary to support these activities.

Operating Expenses ($10.06 million)

Operating Expenses remains the same as the FY 2007 Request. These include direct costs of supplies, equipment, and other operating expenses necessary for the management of NSF’s research and education activities. Operating Expenses also includes services for technical assistance in award oversight and monitoring consistent with NSF’s implementation of the Competitive Sourcing initiative.

Travel ($8.95 million)

Travel request remains the same as the FY 2007 Request. These resources fund travel required for 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 ($77.16 million)

The FY 2008 request for Technology and Tools is $77.16 million, a decrease of $7.04 million, or -8.4 percent, from the FY 2007 Request of $84.20 million. These investments consist of three major components: Information Technology, Space Rental, and Other Infrastructure.

Technology and Tools Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
Information Technology	$35.48	$51.62	$42.18	-$9.44	-18.3%
Space Rental	20.81	23.88	26.28	2.40	10.1%
Other Infrastructure	9.99	8.70	8.70	-	-
Total, Technology and Tools	$66.28	$84.20	$77.16	-$7.04	-8.4%

Totals may not add due to rounding.

Information Technology

The FY 2008 Information Technology request is $42.18 million, a decrease of $9.44 million from the FY 2007 Request. This request provides basic maintenance for ongoing operations and continued participation in E-Gov initiatives, without implementing new capabilities for NSF grants management applications or modernizing legacy applications and automation of existing paper-based or manual processes.

Summary of Information Technology by Function
(Dollars in Millions)

Information Technology	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
Next Generation Grants Mgmt & e-Gov Initiatives	$3.00	$10.70	$11.00	$0.30	2.8%
IT Infrastructure Maintenance and Operations	19.20	22.27	17.60	-4.67	-21.0%
IT Security and Privacy	2.44	5.00	3.97	-1.03	-20.6%
IT Management	0.60	1.10	0.73	-0.37	-33.6%
Applications Maintenance	10.24	12.55	8.88	-3.67	-29.2%
- Finance and Administrative Applications	*4.30*	*4.30*	*3.21*	*-1.09*	*-25.3%*
- FastLane and Legacy Grants Applications	*5.94*	*8.25*	*5.67*	*-2.58*	*-31.3%*
Total, Information Technology	$35.48	$51.62	$42.18	-$9.44	-18.3%

Totals may not add due to rounding.

- ***Next Generation NSF Grants Management and e-Government Initiatives***
  In FY 2008, funding for these initiatives will increase from $10.70 million to $11.00 million. This modest funding increase will allow NSF to maintain its grant management applications at current levels and to continue participating in e-Government initiatives. Planning for major new capabilities will be initiated but full implementation will be delayed, in areas such as adopting new technologies in business processes, enhancing organizational productivity, and ensuring accessibility to a broadened group of participants.

This increase will partially fund NSF's multi-year plan for modernizing several of the legacy applications that support internal grants management activities. 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 been undergoing a phased modernization effort. A cornerstone of our high priority modernization effort is eJacket, a web-based application, which has evolved from a search and retrieval application for submitted proposals, to an investment that has replaced many of the paper processes and legacy (non Web-based) systems used by NSF.

The request will support e-Government initiatives including the Human Resources Line of Business [see Management of Human Capital section], E-Authentication and maintenance support for E-Travel and E-Payroll initiatives.

Other high priority investments that are partially funded and will be implemented in future years include a public citations dissemination effort. The public citation work will provide public access to grant award information including references to publication citations and related reports that will enhance the public's awareness of NSF's current and future research activities.

- ***IT Infrastructure Maintenance and Operations***
  In FY 2008, support for IT Infrastructure Maintenance and Operations will decrease from $22.27 million to $17.60 million. This funding provides basic maintenance and operations levels for ongoing operations and provides limited support for new efforts essential for system modernization, such as directory services and tools to manage configuration, quality assurance, and software testing. Some initiatives will be implemented in future years, such as: deploying the next generation network, providing a new enterprise database solution, and providing additional remote access capabilities to support and increase the productivity of teleworkers and traveling staff.

  Funding will also provide for reduced levels of basic help desk services which support both business applications and desktop configuration management. New application support will be limited and planned improvements will be postponed.

- ***IT Security and Privacy***
  In FY 2008, NSF will decrease funding from $5.0 million to $3.97 million from the FY 2007 level. This is a major increase, $1.53 million, over the FY 2006 Request. This funding provides basic IT security services and continued protection of sensitive information as required by privacy policies. Funding will also support implementation of functionality to address new mandates for improved controls to assure protection of privacy and sensitive information. NSF will fully fund certification and accreditation of activities including risk assessments, security control testing, contingency planning, and implementation and evaluation of a business continuity capability.

  Continued investment in robust solutions is needed to meet evolving and more serious threats. Critical investments will be needed to support specific areas such as: network security, application security, security control testing and tools, automated vulnerability assessment tools, and remediation and intrusion detection services.

- ***IT Management***
  In FY 2008, NSF will decrease spending from $1.10 million to $0.73 million. This investment includes services that support Chief Information Officer requirements for managing NSF's IT investment portfolio. FY 2008 funding will support enterprise architecture efforts that define current, target, and transitional architecture to frame future NSF IT 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 2008, NSF will decrease support for this activity from $12.55 million to $8.88 million. FY 2008 efforts will be limited to maintenance of critical systems such as finance and administrative applications, FastLane, and legacy grants applications.

Summary of Space Rental and Other Infrastructure by Function
(Dollars in Millions)

Space Rental & Other Infrastructure	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
Space Rental	$20.81	$23.88	$26.28	$2.40	10.1%
Other Infrastructure	9.99	8.70	8.70	-	-
- Administrative Contracts	*3.71*	*3.81*	*3.63*	*-0.18*	*-4.7%*
- Government Goods and Services	*4.13*	*2.52*	*3.00*	*0.48*	*19.0%*
- Administrative Services Equipment & Supplies	*2.13*	*2.37*	*2.07*	*-0.30*	*-12.7%*
Total, Space Rental & Other Infrastructure	$30.80	$32.58	$34.98	$2.40	7.4%

Space Rental

The FY 2008 request for Space Rental is $26.28 million, an increase of $2.40 million, or 10.1 percent, over the FY 2007 Request. These resources will offset escalating GSA rental costs, increased real estate taxes, rising utility costs, and additional leased office space. The additional office space comprises $1.20 million of the increase and includes rent for new space as well as annualizing costs for space acquired in the previous year.

Other Infrastructure

In FY 2008, support of Other Infrastructure will remain unchanged at $8.70 million.

Other Infrastructure funding supports three major sets of activities:

> *Administrative Contracts* support will decline slightly from $3.81 million to $3.63 million as services for proposal delivery and panel support will be pared back. Administrative contracts are used to provide facility management and administrative support services.

Government Goods and Services support will increase from $2.52 million to $3.00 million. This category of expenditures covers security guards and building improvements such as electrical upgrades and building renovations. The increase is due to rising costs of security guards and the need to maintain and, in some cases refresh, the agency's physical infrastructure.

Administrative Services Equipment and Supplies will decrease slightly from $2.37 million to $2.07 million. With eJacket becoming the official record at NSF, printing at NSF is transitioning from batch process to on-demand. This new process requires multi-function copiers and scanners, which are also needed for decentralized e-records support. This initiative, which will reduce printing costs and eliminate manual recordkeeping of nearly 100,000 proposal jackets, will be deferred to future years.

Agency Operations and Award Management 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 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Percent
Travel and Transportation of Persons	$6,118	$8,970	$8,970	-	-
Transportation of Things	271	200	200	-	-
Rental Payments to GSA	20,816	23,888	26,280	2,392	10.0%
Communications, Utilities and Misc. Cha	1,459	1,500	1,600	100	6.7%
Printing and Reproduction	209	175	132	-43	-24.6%
Advisory and Assistance Services	11,024	12,471	11,018	-1,453	-11.7%
Other Services	9,968	10,205	10,231	26	0.3%
Purchases of Goods & Srvcs from Gov't.	4,223	2,515	3,000	485	19.3%
Medical Care	764	575	575	-	-
Operations and Maintenance of Equipme	29,927	37,525	28,490	-9,035	-24.1%
Supplies and Materials	4,245	2,600	1,682	-918	-35.3%
Equipment	4,827	9,718	11,123	1,405	14.5%
Subtotal, GOE	93,851	110,342	103,301	-7,041	-6.4%
Salaries and Benefits (PC&B)	153,206	171,480	182,289	10,809	6.3%
Total, AOAM	$247,057	$281,822	$285,590	$3,768	1.3%

Totals may not add due to rounding.

Description of categories:

- **Travel and Transportation of Persons** remain level over the FY 2007 Request. 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 2007 Request.

- **Rental Payments to GSA** includes the rent charged by GSA for NSF's facility in Arlington, Virginia, and additional floors in an adjacent building. The increase of $2.39 million in FY 2008 is required to fund GSA’s estimate for currently occupied space, real estate taxes, an increase in Federal Protective Service 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. The increase of $100,000 is driven by normal inflationary increases.

- **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 decrease by $43,000 from the FY 2007 Request.

- **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. Funding for this activity decrease $1.46 million from the FY 2007 Request.

- **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 2008 request for other services increases slightly by $26,000 over the FY 2007 Request, to bolster award oversight and management efforts as well as increases in physical security, physical infrastructure and maintaining 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 2008 request increases by $485,000 primarily to cover renovation costs and the rising costs of security guards.

- **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. Funds for this activity remain unchanged from the FY 2007 Request.

- **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 decrease by $9.04 million in FY 2008 which will continue operations of legacy applications and existing paper-based or manual processes.

- **Supplies and Materials** include office supplies, library supplies, paper and supplies for the NSF central computer facility, and miscellaneous supplies. Funding for this activity decreases by $918,000 over the FY 2007 Request.

- **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 $1.405 million in FY 2008.

NATIONAL SCIENCE BOARD $4,030,000

The National Science Foundation (NSF) Authorization Act of 2002 provided for a separate appropriation line item for the National Science Board (the Board) beginning in FY 2003. Accordingly, this FY 2008 Budget Request identifies the resources needed to support the Board, including amounts for personnel compensation and benefits, authorized travel, employment of external experts and consultants, and other appropriate expenses. The FY 2008 Request is $4.03 million, an increase of $120,000, or 3.1 percent, over the FY 2007 Request of $3.91 million. The FY 2008 Budget Request will continue to enable the Board to fulfill its policy-making and oversight responsibilities for 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 2006 Actual	FY 2007 Request	FY 2008 Request	Change Over FY 2007 Request Amount	Percent
Personnel Compensation and Benefits	$1.62	$1.70	$1.86	$0.16	9.4%
Other Operating Expenses	2.32	2.21	2.17	-0.04	-1.8%
Total, NSB	$3.94	$3.91	$4.03	$0.12	3.1%
Full-Time Equivalent Employees	15	14	14	-	

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.), $4,030,000: *Provided*, That not more than $9,000 shall be available for official reception and representation expenses.

National Science Board
FY 2008 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Rescission	Total Resources	Expired	Obligations Incurred/Est.
FY 2006 Appropriation	$4.00	-$0.05	$3.95	-$0.01	$3.94
FY 2007 Request	3.91	-	3.91	-	3.91
FY 2008 Request	4.03	-	4.03	-	4.03
$ Change from FY 2007					$0.12
% Change from FY 2007					3.1%

Subtotals may not add due to rounding.

Within the Office of the National Science Board FY 2006 appropriation, a total unobligated balance of $7,473 expired.

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 Board. The Board was established by the Congress both to serve as an independent national science policy body, and to oversee and guide the activities of NSF. It has dual responsibilities to: a) provide national science policy advice to the President and the Congress; and b) establish policies for NSF. The Board has 24 members appointed by the President and confirmed by the Senate. Board 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 Board 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 Board 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 chairmen 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 Board to monitor the quality and effectiveness of this keystone Foundation process.

The Board 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 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, *Science and Engineering Indicators*. *Science and Engineering Indicators 2006* was released by the President in February 2006. The Board's accompanying policy report entitled *America's Pressing Challenge – Building a Stronger Foundation* highlighted troubling trends in our Nation's K-12 science, technology, engineering, and mathematics (STEM) education enterprise, and provided recommendations to address this issue.

During the last year, the Board accomplished a great deal in terms of its mission to provide oversight and policy directions to the Foundation, including: reviewed and endorsed the OIG Semi-annual Reports to Congress and approved NSF management responses; approved the NSF FY 2008 Budget Submission for transmittal to OMB; approved the Foundation's annual Merit Review Report; provided review and decisions on major awards or proposal funding requests; implemented a process for the development, review, approval, and prioritization of large facility projects by NSF, and reprioritized Board-approved Major Research Equipment and Facilities Construction (MREFC) account projects that had not yet received MREFC funding. The Board provided a bold new vision for NSF as part of its report entitled, *The National Science Board 2020 Vision for the National Science Foundation*, and approved a new strategic plan for NSF based on that vision.

In terms of advice to the President and the Congress, the Board is poised to make broad recommendations for a nationally coordinated hurricane research initiative with specific guidance for the role of NSF; has conducted three national hearings on K-16 STEM education; established a special Board Commission on STEM Education in the 21st Century that will be developing a national action plan for addressing the critical STEM education needs of our Nation while providing specific guidance for the role of NSF in the national STEM education enterprise; and is conducting national and international hearings and roundtable discussion to support its examination of the role of the federal government in supporting international S&E partnerships. The Board has provided testimony to Congress; interacted with the White House Office of Science and Technology Policy in meetings and forums on science and engineering issues; and responded to specific questions and inquiries from Senators and Representatives. Board meetings and deliberations continue to be more open in accord with the Government in the Sunshine Act, as directed by the NSF Act of 2002. The Board continues to improve its outreach and communications with the Congress, other agencies, various interest groups and the outside science and engineering research and education community.

The Board's Task Force on Hurricane S&E and Task Force on Transformative Research will both be finalizing their respective reports in FY 2007. These reports will provide broad recommendations regarding our Nation's research enterprise, as well as specific guidance for the roles that NSF should play in these efforts. During FY 2007, the Board will continue its initiative to develop improvements to and impact of the biennial *S&E Indicators* report, and begin steps to premiere a new condensed volume of the report in FY 2008.

National Science Board FY 2008 Budget Request

The Board's FY 2008 Budget Request 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 the continued 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 workforce, research infrastructure, size and duration of grants, and underrepresented populations and regions.

Effective communications and interactions with our constituencies contribute to the Board's work of identifying priority science and technology 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 science and engineering research and education community, Congress, federal science and technology 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 science and technology enterprise in this country, and will ensure a principal role for NSF programs in providing a critical foundation for science and engineering research and education.

Among other activities in FY 2008, the Board expects to complete the work of the Commission on 21st Century Education in Science, Mathematics and Technology by making a formal report to the Congress. While many of these recommendations will be at a national system level, a number will focus specifically on the role NSF can and should play in supporting the development of an adequate and diverse science and engineering workforce. The Board will continue to review and approve NSF's actions for creating major NSF programs and funding, and expects new efforts to be implemented regarding enhancement of NSF support for potentially transformative research as a result of new Board guidance.

Several endeavors that the Board expects to formally complete by the end of FY 2007 will require significant follow-up outreach efforts by the Board in FY 2008 to ensure the desired impacts are realized. For example, lessons learned by the Board's experience with its 1982 STEM Education Commission report and the 2001 report on the role of the federal government in supporting international science, have provided clear and strong lessons on the importance of the Board undertaking significant follow-up efforts to ensure action based on their reports. While the Board's Commission on 21st Century Education in Science, Mathematics and Technology will complete its work in late FY 2007, it is clear that much follow-up outreach by the Board will be required throughout FY 2008 to ensure the work of the commission has the highest possible impact. Likewise, the Board's Task Force on International S&E partnerships will complete its work at the end of FY 2007, but will require significant follow-up by the Board in FY 2008 to avoid a repeat of the low impact of the Board's previous report on this topic.

The Board will be producing a new component to their biennial *S&E Indicator*s report in FY 2008 that will require significant new effort on the part of the Board. In addition, the Board will continue to review and approve NSF's actions for creating major NSF programs and funding large projects in FY 2008, as well as dealing with evolving NSF policy issues. Experience has demonstrated that the Board will receive a number of requests from Congress asking that the Board examine and report quickly on a wide range of national policy topics related to S&E research and education. The Board welcomes such Congressional and Administration requests, and will itself continue to identify high priority topics focused specifically on NSF, or more broadly on national S&E policy issues that it feels it should examine in FY 2008.

Essential to the conduct of Board business is a small and independent core of full-time senior policy, clerical, and operations staff, supplemented by temporary contractual support as needed for various Board endeavors. This core of Board support is augmented by the Foundation as it continues to provide accounting, logistical, and other necessary resources in support of the Board and its missions. In addition to the Board Office's essential and independent resources and capabilities, external advisory and assistance services continue to be critical to support production of Board reports and supplement the

Board Office 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 Board Office senior S&E policy staff, and the clerical positions as Board Office staff that support operations and related activities associated with the conduct of Board meetings and oversight responsibilities. The Board Executive Officer, who reports directly to the Board Chairman and also serves as the Director of the Board Office, continues to identify options for broadening the Board Office staff capabilities to better support the broad mission of the Board. The Board Office 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 will occur in FY 2008 with increased attention to addressing new skill requirements. Nevertheless, the results of a strategic restructuring of the Board Office management and operations over the last three years has led to more efficient use of appropriated resources while retaining the ability to support an active Board agenda.

Personnel Compensation and Benefits and General Operating Expenses

(Dollars in Thousands)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Personnel					
Personnel Compensation and Benefits	$1,620	$1,700	$1,862	$162	9.5%
General Operations					
Staff Development & Training	25	25	25	-	-
Advisory & Assistance Service	1,420	1,306	1,279	-27	-2.1%
Other Services	220	230	180	-50	-21.7%
Travel	456	450	500	50	11.1%
Communication, Supplies & Equipment	190	190	175	-15	-7.9%
Representation Costs	9	9	9	-	-
	$3,940	$3,910	$4,030	$120	3.1%

Totals may not add due to rounding.

OFFICE OF INSPECTOR GENERAL $12,350,000

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 2008 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 2008 Budget Request for OIG is $12.35 million, which represents an increase of $490,000, or 4.1 percent, over the FY 2007 Request of $11.86 million.

Office of Inspector General Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Personnel Compensation and Benefits	$8.14	$8.20	$8.51	$0.31	3.8%
Other Operating Expenses[1]	3.33	3.66	3.84	0.18	4.9%
Total	$11.47	$11.86	$12.35	$0.49	4.1%
Full-Time Equivalent Employment	63	63	63	-	

Totals may not add due to rounding.
[1] Includes the costs of the annual financial statements audit and the outsourcing of contracting services.

Appropriation Language

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, as amended, $12,350,000, to remain available until September 30, 2009.

Office of Inspector General
FY 2008 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Rescission	Carryover/ Recoveries	Total Resources	Obligations Incurred/Est.
FY 2006 Appropriation	$11.50	-$0.15	$1.14	$12.50	$11.47
FY 2007 Request	11.86	-	1.01	12.87	12.87
FY 2008 Request	12.35	-	-	12.35	12.35
$ Change from FY 2007					-$0.52
% Change from FY 2007					-4.0%

Subtotals may not add due to rounding.

Explanation of Carryover

Within the Office of Inspector General (OIG) appropriation, a total of $1.01 million was carried forward into FY 2007 to cover priority audits that are contracted out; fund contracts for financial analysis and other technical support for OIG investigations; provide contract support for information technology and other administrative needs of the office; and fund personnel compensation costs.

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. Since FY 2006, funds to cover the complete cost of the financial audit have been 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 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Personnel Compensation and Benefits	$8,143	$8,200	$8,510	$310	3.8%
Travel & Transportation of Persons	212	270	280	10	3.7%
Advisory & Assistance Services[1]	2,814	3,060	3,220	160	5.2%
Communications, Supplies and Equipment, and Other Services	301	330	340	10	3.0%
Total	$11,470	$11,860	$12,350	$490	4.1%

Totals may not add due to rounding.
[1] Includes the costs of the annual financial statements audit and the outsourcing of contracting services.

The OIG request for FY 2008 includes funding for the annual audit of NSF's financial statements. 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.

The increase requested for FY 2008 will be applied primarily to higher personnel costs and to the escalating costs of audits conducted by CPA firms under contract to OIG. With the additional contracting resources, our primary audit focus will address five areas that we believe pose the greatest challenge to the agency: (1) award oversight and monitoring, including the management of large infrastructure projects and NSF's execution and refinement of a risk-based program for monitoring its 35,000 active awards; (2) NSF processes for safeguarding information assets, particularly personally identifiable information, as directed by OMB; (3) planning and implementation of the new administrative requirements to identify, test, and report on financial reporting controls under the Federal Managers Financial Integrity Act; (4) 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 (5) specific program issues, such as the management of the U.S. Antarctic Program and the transparency of NSF's merit review process.

To avoid potential conflicts of interest with NSF and to expedite the processing of our contracts, we will enter into an interagency agreement with the Department of the Treasury to administer all OIG audit, investigation, and other contracting services in FY 2008. The office has tested this approach over the past year by splitting OIG contract servicing between NSF and the Treasury agency. We found that using the third-party contracting office eliminated the possibility of conflict, e.g., in the event of an OIG audit or investigation of NSF contracting operations, and provided efficient and timely servicing of our contracting requirements. For FY 2008, therefore, we are requesting additional funding to cover the estimated $250,000 cost of outsourcing contract administration services that have previously been funded under the NSF appropriation.

As NSF's budget experiences substantial growth under the American Competitiveness Initiative (ACI) in the coming years, OIG will maintain effective oversight of the greater risks posed by expanding NSF programs and awards. OIG will continue to improve its ability to target risky awardees by refining its automated trend analysis techniques for scanning prior OIG and A-133 audit findings and by achieving a better understanding of the potential vulnerabilities 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. OIG will 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 will 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.

In support of the ACI, OIG will help ensure that each additional dollar NSF invests in basic research is subject to appropriate oversight and sound management controls. With their emphasis on efficiency and effectiveness, OIG program audits support efforts to increase NSF's operational capacity at a reasonable cost to the taxpayer. In the past our audits have focused on many of the priorities identified in the ACI. For example, we have issued a number of audit reports over the past few years that focus on NSF's investment in "tools of science," i.e., large-scale facilities and instruments that enable discovery and development. Following our recommendations, NSF is in the process of reengineering its approach to planning, building, and managing these projects. A series of recent audit reports have also recommended improvements in the way NSF disseminates research results. These changes should facilitate technology transfer, enhance researcher access to information useful for their own work, and accelerate the process by which basic research enables the introduction of successful new products. As NSF attempts to leverage its investments by entering into a growing number of international partnerships, OIG has played a leadership role in establishing a dialogue among international organizations responsible for science research funding to discuss strategies for addressing mutual accountability challenges.

Additional resources are also needed to continue the expansion of 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 and reliability. More resources would allow the Office to continue to improve its Quality Control Review program and, in turn, the quality of the A-133 audits.

Our criminal, civil, administrative, and research misconduct investigative cases continue to become more complex, requiring increased interaction with NSF, awardee administrators, international organizations, and the Department of Justice in order to obtain the appropriate resolutions. Prosecutions of our civil and criminal cases are increasingly resulting in financial settlements for institutional fraud and compliance programs to protect the federal interest in the future. Based largely on our recent investigative experience, we have initiated proactive reviews that have successfully detected fraud and mismanagement. These efforts require increasing use of forensic financial services to develop persuasive investigative evidence. We have also successfully investigated a growing number of research misconduct and international collaboration cases. The latter cases, in particular, require substantial resources to determine their scope and complexity and to perform the more-intricate international investigations, and this request provides the funding required to meet that need. We anticipate that cases handled in FY 2008, like our current cases, will offer the potential for greater recoveries and significant systemic changes in institutions, with a concomitant improvement in institutional detection of fraud and greater assurance that federal funds will be put to proper use. Under our monitoring, the systemic changes will also promote higher ethical conduct in the application for and execution of federal awards. These cases require significantly more staff time, as well as specialized knowledge, and strong forensic, computer, and analytical skills. This request will provide additional resources to ensure diligent investigations of the growing number of substantive complaints and to enable us to respond to emerging situations, such as the post-Katrina efforts, cybercrimes, and challenges to NSF's cybersecurity at NSF, its funded institutions, and remote locations like Antarctica.

OIG will continue its commitment to a strong outreach effort to educate NSF staff and the national and international research communities to help them avoid the kinds of problems that lead to investigations, unfavorable audit findings, or administrative corrective actions. This initiative is aimed at making NSF staff, awardee institutions, international collaborators, and other researchers more aware of 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 funding, 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 organizing and participating in 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. We will also continue to work closely with other IG offices on issues that are of concern across the IG community.

MAJOR MULTI-USER RESEARCH FACILITIES $1,153,820,000

The FY 2008 Request includes $1,153.82 million for major multi-user research facilities, a $64.28 million increase, or 5.9 percent, over the FY 2007 request of $1,089.54 million. All operations and maintenance of multi-user facilities and research resources are funded through the Research and Related Activities (R&RA) account, and 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 2006 Actual	FY 2007 Request	FY 2008 Request	Change Over FY 2007 Amount	Percent
Facilities	828.78	899.74	954.88	55.14	6.1%
Federally Funded R&D Centers	184.31	189.80	198.94	9.14	4.8%
Total, Major Multi-User Research Facilities	$1,013.09	$1,089.54	$1,153.82	$64.28	5.9%

This chapter provides descriptions of each major multi-user research facility supported through the R&RA account and provides funding information by life cycle phase for each facility. The information presented for each facility follows the overall framework established by NSF for large facility projects.

The Large Facilities Manual, to be released in FY 2007, will provide guidance on the policies, procedures, and requirements related to planning, construction, management, and oversight of a large facility project throughout its life cycle.

For more information on the construction projects funded through NSF's MREFC account, please see the MREFC chapter.

Major Multi-User Research Facility Funding
(Dollars in Millions

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change Over FY 2007 Amount	Change Over FY 2007 Percent
Facilities	**$828.78**	**$899.74**	**$954.88**	**55.14**	**6.1%**
Academic Research Fleet	$62.21	$77.50	$80.60	$3.10	4.0%
Advanced Modular Incoherent Scatter Radar[1]	$7.50	-	-	-	-
Cornell Electron Storage Ring	$14.62	$14.71	$14.71	-	-
Gemini Observatory	$18.18	$20.00	$20.50	$0.50	2.5%
Incorporated Research Institutes for Seismology	$11.41	$12.90	$11.40	-$1.50	-11.6%
Integrated Ocean Drilling Program[2]	$32.19	$6.50	$4.64	-$1.86	-28.6%
Large Hadron Collider	$13.36	$18.00	$18.00	-	-
Laser Interferometer Gravitational Wave Observatory	$31.68	$33.00	$28.20	-$4.80	-14.5%
MREFC Projects[3]	$250.75	$294.10	$335.25	$41.15	14.0%
National High Magnetic Field Laboratory	$25.74	$26.50	$29.00	$2.50	9.4%
National Nanofabrication Infrastructure Network	$14.43	$13.89	$13.89	-	-
National Superconducting Cyclotron Laboratory	$17.34	$17.60	$19.50	$1.90	10.8%
Network for Earthquake Engineering Simulation	$21.03	$21.27	$22.17	$0.90	4.2%
Other Facilities[4]	$14.09	$13.26	$15.76	$2.50	18.9%
Polar Facilities & Logistics	$294.25	$330.51	$341.26	$10.75	3.3%
Federally Funded R&D Centers[5]	**$184.31**	**$189.80**	**$198.94**	**$9.14**	**4.8%**
National Astronomy and Ionosphere Center	$12.15	$12.16	$12.15	-$0.01	-0.1%
National Center for Atmospheric Research	$84.51	$86.85	$90.87	$4.02	4.6%
National Optical Astronomy Observatory	$36.91	$40.05	$43.18	$3.13	7.8%
National Radio Astronomy Observatory	$50.74	$50.74	$52.74	$2.00	3.9%
Grand Total	**$1,013.09**	**$1,089.54**	**$1,153.82**	**$64.28**	**5.9%**

[1]Final construction funding for the Advanced Modular Incoherent Scatter Radar (AMISR) facility was provided in FY 2006. Funding for the operations and maintenance of AMISR, estimated to be approximately $3.0 million annually, is provided through Research Resources, a category not reported on this table.
[2]FY 2006-07 support for IODP includes funding for the continued phase out of program and contract activities for the Ocean Drilling Program, predecessor to the IODP.
[3]Funding levels for MREFC projects in this table include support for concept and development associated with these projects, initial support for operations and maintenance, both provided through the R&RA account, and implementation support provided through the MREFC account.
[4]Other Facilities includes support for other physics and materials research facilities.
[5]Federally Funded R&D Centers does not include the Science and Technology Policy Institute, which is an FFRDC but not a research platform.

Academic Research Fleet

Project Description: The Academic Research Fleet consists of 24 vessels in the University-National Oceanographic Laboratory System (UNOLS). These vessels range in size, endurance, and capabilities, enabling NSF and other federally funded scientists with the means to conduct ocean science research with a diverse fleet capable of operating in coastal and open ocean waters. Funding provides for the Academic Research Fleet includes investments in 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. Scientists contribute to advances made in areas such as climate variability, marine ecosystems, fisheries, and ocean-related natural hazards such as tsunamis through use of these facilities.

Principal Education Goals: Vessels in the Academic Research Fleet permit shipboard training of future oceanographers. Participating graduate and undergraduate students interact with scientists and marine technicians, enabling them to gain first-hand exposure to ocean science field research. Recent technological innovations allow research conducted at sea to 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). The operating funds for the Fleet are divided proportionally among the vessel users; NSF's portion is approximately 70 percent of the total. 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) at NSF, at NOAA, and at 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 supporting ocean science research will be needed far into the future. In coordination with the other federal agencies with ocean research investments and UNOLS, the International Working Group for Facilities (IWG-F) 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. In addition, several activities are requested or underway to support the upgrade of the U.S. Academic Research Fleet.

FY 2008 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 a total of six years and cost approximately $22.0 million; an increase over previous estimates due to rise in titanium costs. The FY 2008 support for this effort is $3.0 million. A second 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 years starting in FY 2007. FY 2008 support for this activity is planned for $14.0 million. A design competition was completed and two U.S. shipyard/design agent consortia were selected to each produce a design and bid on construction by summer 2007. 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.

<u>Funding Profile</u>: 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	RCRVs	Other		
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	8.63	1.74	3.63		62.21	$76.21
FY 2007 Request	5.10		15.10		77.50	$97.70
FY 2008 Request	3.00		14.00		80.60	$97.60
FY 2009 Estimate			10.00		89.00	$99.00
FY 2010 Estimate			12.00		95.00	$107.00
FY 2011 Estimate			14.00		101.00	$115.00
FY 2012 Estimate			16.00		108.00	$124.00
FY 2013 Estimate			18.00		115.00	$133.00

NOTE: Operations estimates for FY 2009 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, the Federal Oceanographic Facilities Committee (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 the IWG-F, which subsumed the FOFC; however, significant changes for renewal of the academic fleet are not anticipated. Major upgrade expenditures indicated in implementation requests for FY 2007 and outyears 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 amount 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: The existing interagency MOU 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 sensitivity comparable to the radar currently operating in Sondre Stromfjord, Greenland. Each of the three fixed antenna faces is 35 meters square with 3,000 to 4,000 radiating elements. 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 energy entering the upper atmosphere at the poles 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, 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 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 amplifiers for the first 4,000 units were manufactured by Comtech PST, a company based in Melville, New York. 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 (PAT) has been appointed, which includes the Deputy Director for Large Facility Projects and members from GEO, the Office of Polar Programs, the Office of Budget Finance and Award Management, and the Office of the General Counsel. 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 (PEP) that describes the AMISR work breakdown structure, management structure, project milestones, and final test and acceptance plan.

Current Project Status: 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. An additional 65 panels were assembled at SRI and shipped to Alaska in Fall 2006, completing the first AMISR face. January 2007 marks the start of operations for the 97-panel system at Poker Flat with two weeks of observations in conjunction with a NASA sounding rocket campaign. A second joint radar and rocket campaign will be conducted in February 2007. Construction materials for the two AMISR faces being deployed at Resolute Bay were shipped to the site in August 2006. Panels for the two AMISR faces at Resolute Bay will be manufactured, integrated, and tested at SRI in 2007 for shipment in August 2007. The Resolute Bay faces will be constructed and tested in the first half of 2008.

Milestones for the project are outlined below:

FY 2006 Milestones:
- Poker Flat Activities
  - Continued operation and testing of 32 panels
  - Integrated and tested remaining 65 panels at SRI
  - Shipped and installed remaining 65 panels at Poker Flat
  - Poker Flat system test complete and operational
- Resolute Bay Activities:
  - Support scaffolding and distribution shelters shipped to Resolute Bay via sealift

FY 2007 Milestones:
- Poker Flat Activities
  - Complete system testing of 97-panel radar
  - Scientific operations of 97-panel radar begin
- Resolute Bay Activities:
  - Manufacture Antenna Element Units (AEUs)
  - Integrate and test panels at SRI
  - Ship completed panels to Resolute Bay via sealift

FY 2008 Milestones:
- Poker Flat Activities
  - Continue operations
- Resolute Bay Activities
  - Construct support platforms
  - Install complete panels on two antenna faces
  - System testing of completed faces
  - Operations begin

Funding Profile: The implementation phase of AMISR began late in FY 2003 with an initial allocation of $14.0 million. The total cost to construct AMISR is $44.0 million, as illustrated below. NSF provided the final year of implementation funding in FY 2006.

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		10.50	0.50	$11.00
FY 2006		7.50	2.70	$10.20
FY 2007 Request			3.00	$3.00
FY 2008 Request			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			3.22	$3.22
FY 2013 Estimate			3.30	$3.30

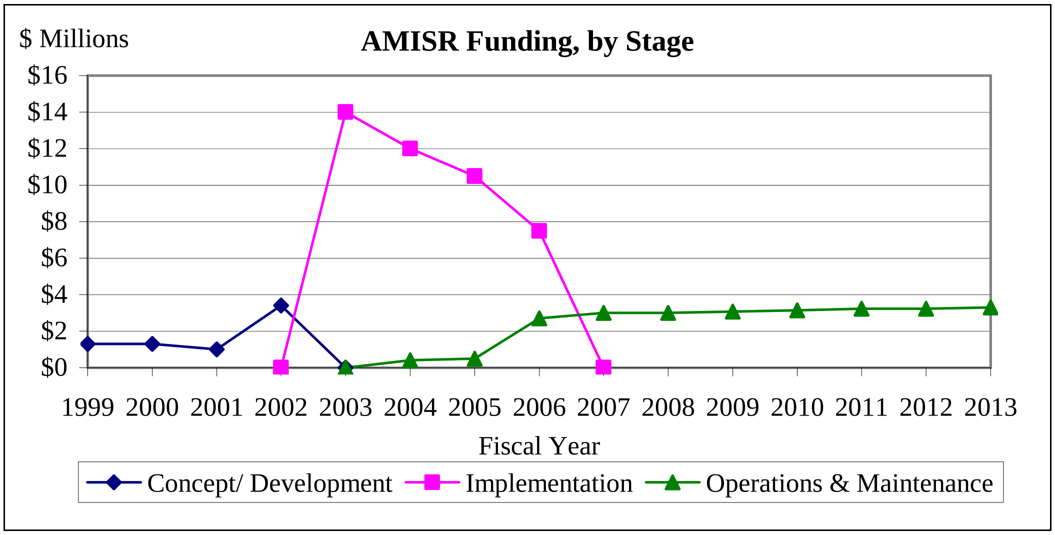
NOTE: A steady state of about $3 million in operations support is expected to occur in or about FY 2007. The expected operational lifespan of this project is 40 years, beginning in FY 2007. Operations estimates for FY 2009 and beyond have been developed based on current cost profiles and are not intended 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: NSF provided final implementation funding for AMISR in FY 2006. The actual implementation phase will be complete, and the AMISR faces at Resolute Bay will be operational by spring 2008.

- Operations and Maintenance: SRI successfully competed for the initial operation and maintenance of the AMISR systems at Poker Flat and Resolute Bay. Funding began in FY 2006 under a five-year cooperative agreement; 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, the University of Calgary, and the University of Saskatchewan. Additional instrumentation for the two facilities will be funded with R&RA funding through grants programs within ATM.



Associated Research and Education Activities: 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 are returned from remote sites. AMISR remote access will utilize a workbench concept consisting of several components, including databases, visualization software, web sites, and other tools. This will engage a new generation of students in the exciting research opportunities enabled by incoherent scatter observations. It will also provide a means for effective teaching of fundamental principles of radio science. Exposure to AMISR-related research will offer experience in basic atmospheric science, electrical engineering, radiowave communications, signal processing, computer design, and information technology. The possibilities for new discoveries, combined with the ease of operation, will inspire hundreds of young scientists from all over the globe.

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 (SRF) 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: CESR's principle education goals are to support and enhance Ph.D. level graduate education, postdoctoral research experience, Research Experiences for Undergraduates (REUs), and research experiences for K-12 science teachers. Engendering excitement in science among young children will be a focus for K-12 engagements. An important program element is Teacher Professional Development through the dissemination of effective models and pedagogic approaches to science teaching and partnerships between researchers and educators.

Besides providing forefront research opportunities to women and under-represented minorities through base grants, broadening participation is one of key goals of the CESR REU Site Program, which is enriched substantially by major involvement on the part of physics faculty and students from Wayne State University, a major minority-serving institution.

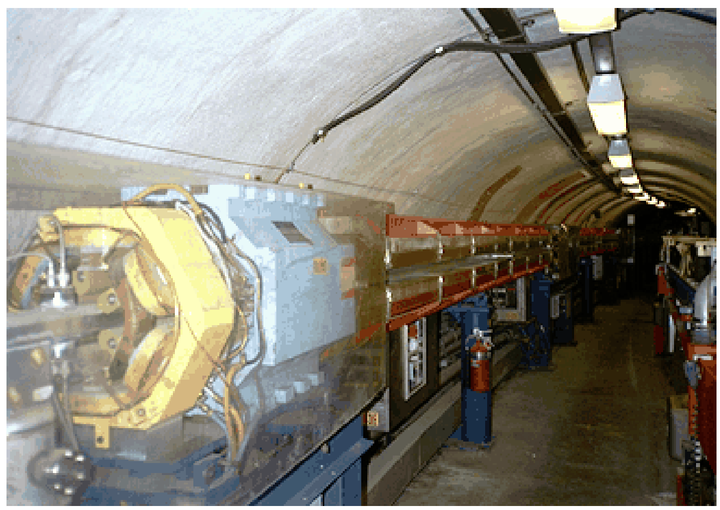
Partnerships and Connections to Industry: CESR staff are transferring CESR SRF technology to industry. Two new industrially fabricated SRF cavity systems have been acquired in order to shorten the CESR bunch length with higher voltage. Through a license arrangement with Cornell, the ACCEL Corporation 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 NSF, and an annual review by a Program Advisory Committee of outside physicists reporting to the Laboratory Director and NSF. A comprehensive review by NSF of the Laboratory and its programs was held at Cornell in April 2006, and involved an external panel of experts chaired by Professor Michael Witherell of UC Santa Barbara.

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. Pending the successful outcome of a renewal proposal, DMR will provide $3.9 million to CHESS in FY 2008; BIO will provide $900,000, and NIH will provide $600,000.

Current Project Status: CESR is reaching the final stages of 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 2008 Request for CESR totals $14.71 million. It is expected that the CESR-c and CLEO-c projects will cease during FY 2009.



The storage ring is on the left side; sextuple (yellow) and quadropole (blue) focusing magnets can be seen in the foreground, with solenoidal bending magnets behind. Part of the synchrotron is visible on the right, and the bending of the tunnel is easily seen. *Credit: Cornell University (www.lns.cornell.edu/public/lab-info/ring.html)*

Funding Profile: The FY 2003 – FY 2009 estimated funding for CESR-c and CLEO-c represents completion of the current program of operations and provides opportunity 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		16.62	$16.62
FY 2006		14.62	$14.62
FY 2007 Request		14.71	$14.71
FY 2008 Request		14.71	$14.71
FY 2009 Estimate		7.50	$7.50
FY 2010 Estimate		-	-

NOTE: Operations estimates for FY 2009 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. NSF support for CESR concludes in FY 2009.

[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 5,000 hours per year for CLEO research and for accelerator physics and development. Maintenance is provided through a weekly eight-hour shift and through two or three three-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 2010.

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

- Over 120 elementary and middle school students and 300 high school students were involved in activities hosted by the Laboratory for Elementary-Particle Physics. Over 500 people toured the Wilson Laboratory facility during this time frame;
- Over 60 undergraduate students participated in laboratory research or worked as technicians or in technical capacities such as computer operations; the laboratory is very active in mentoring programs for students and has hosted 30 REUs in collaboration with Wayne State University and George Mason University;
- The laboratory is very active in mentoring programs for teachers. Sixty-two high school physics teachers participated in several programs including Physics First workshops, Preparing Future Physics Teachers, and the Cornell Institute for Physics Teachers;
- Underrepresented populations are also engaged through EXPLORE! Bridge to Medicine Program and the New York City Region 3 Science Teacher Professional Development Day; and
- The laboratory trains graduate students in accelerator physics and has supported the development of superconducting radio frequency accelerating cavities.

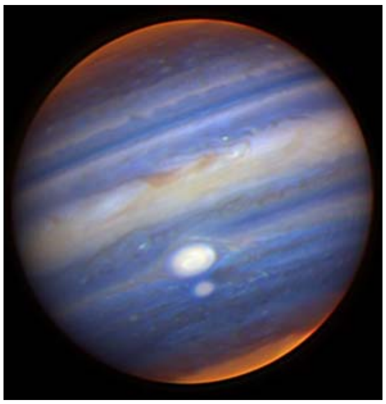
Science Support: Approximately $3.0 million is provided annually by NSF in support of separate awards to external users of the CESR/CLEO facility. The Department of Energy (DOE) provides a similar amount in support of awards to individual investigators and groups. In addition, $660,000 is provided in 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

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.



This image, taken at Gemini North (Mauna Kea, Hawaii) using adaptive optics, is of Jupiter and its two red spots (which apppear white because this is a near-infrared image; in visible light they appear reddish). In this color composite image, white indicates cloud features at relatively high altitudes; blue indicates lower cloud structures; and red represents still deeper cloud features. *Credit: Gemini Observatory/AURA*

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 10 percent of the roughly 500 U.S. users per year are students. Gemini also provides 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 had 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 Observatory 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 is the responsibility of an assigned program manager 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. An independent Visiting Committee, established by the Gemini Board, 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. All AST-funded facilities have established policies and practices designed to broaden the participation of individuals from groups under-represented in the scientific and technological workforce. Under the terms of the international agreement, the partnership, after a management review conducted in 2004, determined that it would not compete the management of the Observatory at that 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 was approved by the National Science Board. A new cooperative agreement for the period FY 2006-2010 has recently been put into place.

Current Project Status: Science operations are routine at both sites; over 90 percent of available time on Gemini North and over 80 percent of time on Gemini South is dedicated to scientific observing. Commissioning of facility instruments continues at both telescopes.

Funding Profile: The FY 2008 Request totals $20.50 million, an increase of $0.50 million over the FY 2007 Request of $20.0 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.

Gemini 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 2004 & Earlier	12.00		47.00	45.00	13.27		72.27	45.00	$117.27
FY 2005					15.48		15.48	-	$15.48
FY 2006					18.18		18.18	-	$18.18
FY 2007 Request					20.00		20.00	-	$20.00
FY 2008 Request					20.50		20.50	-	$20.50
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					26.10		26.10	-	$26.10
FY 2013 Estimate					27.16		27.16	-	$27.16
Subtotal, R&RA	$24.00		$94.00		$283.65		$401.65		
Subtotal, MREFC		-		$90.00		-		$90.00	
Total, Each Stage		$24.00		$184.00		$283.65			$491.65

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 2010. 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 and continued support of instrumentation development.

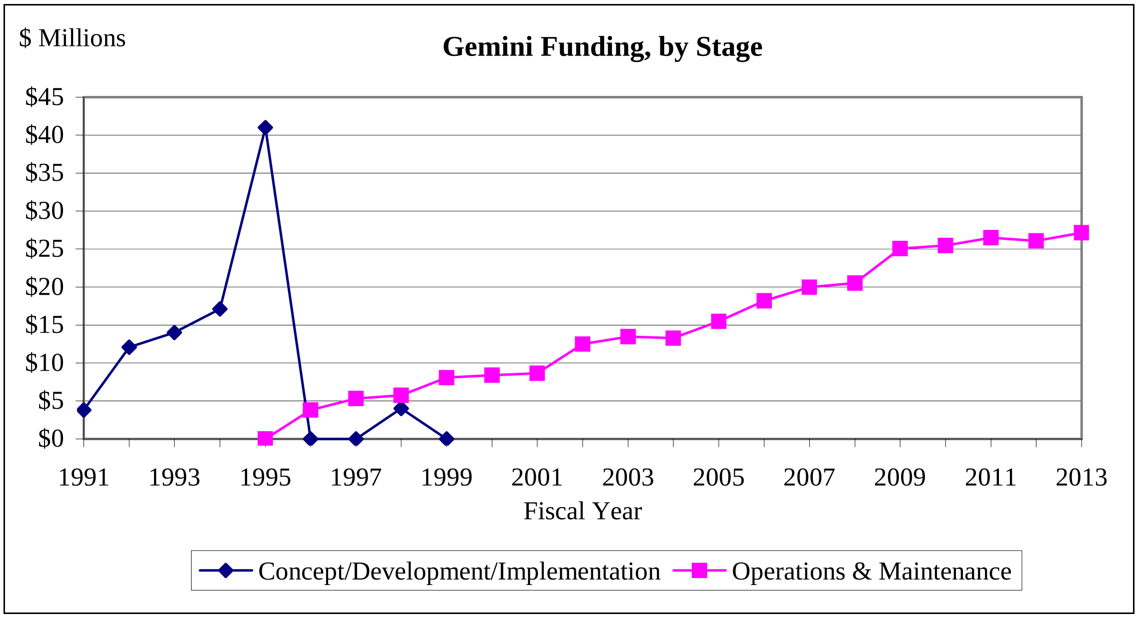
Information pertaining to the data in the table is included below.

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: Neelon Crawford,Polar Fine Art; Gemini Observatory/AURA and NSF*

- 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 expired 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. A new cooperative agreement for the period FY2006-2010 has been put in place.

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. All facility educational and outreach activities seek to broaden participation by under-represented groups. The AST-supported facilities provide forefront research capability and opportunities for access that enable faculty and students from under-represented groups and at diverse institutions to develop and carry out competitive research programs.

Science Support: Peer-review telescope allocation committees provide merit-based telescope time but no financial support. NSF does not provide awards targeted specifically for use of Gemini. Most U.S. users are supported through NSF or NASA grants, or university research support to pursue scientific programs that require use of Gemini. More than 90 percent of the science time on the two telescopes is carried out in a 'queue' mode where the observations are scheduled by Gemini astronomers so as to best match the requirements of the scientific program to the observing conditions. Along with optimizing the productivity of the telescope time, this obviates the need for the scientists to travel to the remote sites, thereby reducing the cost to the researchers.

Incorporated Research Institutes for Seismology (IRIS)

Project Description: IRIS is a consortium of 104 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 (40 terabyte archive); and (4) The IRIS Education and Outreach (E&O) Program, which enables audiences beyond seismologists to access and use seismological data and research for educational purposes, including teacher workshops, student internships, museum exhibits, educational materials, and programs for under-resourced schools.

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

This is an image of the entrance to the Global Seismic Network’s seismic vault on Tristan da Cunha in the South Atlantic. This station is part of a collaboration with the Comprehensive Test Ban Treaty Organization International Monitoring System and Geoscope. *Credit: Ted Kromer.*

Principal Education Goals: The IRIS 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 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 non-profit consortium representing practically all U.S. university and non-profit 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 104 full-member (voting) U.S. universities that operate core research facilities consisting of a GSN, PASSCAL, and a DMS. The FY 2008 Request for IRIS totals $11.40 million, a decrease of $1.50 million below the FY 2007 Request.

<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 2004	3.10	9.90	$13.00
FY 2005	2.85	9.05	$11.90
FY 2006	2.80	8.61	$11.41
FY 2007 Request	3.40	9.50	$12.90
FY 2008 Request	2.80	8.60	$11.40
FY 2009 Estimate	2.90	8.70	$11.60
FY 2010 Estimate	3.00	8.80	$11.80
FY 2011 Estimate	3.10	8.90	$12.00
FY 2012 Estimate	3.20	9.00	$12.20
FY 2013 Estimate	3.30	9.20	$12.50

NOTE: Operations estimates for FY 2009 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 new five-year cooperative agreement with the IRIS Consortium for the continued management of the IRIS facilities (2006-2011) was approved by the NSB in May 2006 and finalized in September 2006.

<u>Associated Research and Education Activities</u>: IRIS sponsors an active education and outreach program, which reaches a vast number of individuals annually. There are over 2,000 individuals on the IRIS mailing list, and over 120 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 that the large increase in public interest after the Sumatra earthquake and tsunami has continued through the past year. The number of posters distributed has continued to increase, through the creation of "A Century of Great Earthquakes" poster in commemoration of the 1906 San Francisco earthquake centennial, the translation of the "Exploring the Earth" poster into Spanish, and a contribution to the American Geophysical Institute's Earth Science Week packet. Sixteen public Distinguished Lectures were given to audiences of up to 400 in FY 2006 in coordination with the Seismological Society of

America. IRIS holds a variety of professional development workshops each year for K-12 teachers and/or college faculty, varying in length from one hour to three days; in FY 2006, six such workshops of one day or more duration were held as well as four one-hour workshops. The teachers listed in the table only include one day or longer workshops. In addition, IRIS provided materials for 17 workshops organized by other groups. The K-12 students number assumes each teacher interacts with 80 students per year and continues to teach new students each year. 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
FY 2006	52,000	9	23	124	12	15,000,000	28,000	1,800,000

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

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*, launched in January 2002, is undergoing testing and will be available for IODP operations in late 2007. NSF's contribution includes rebuilding the ODP drillship *JOIDES Resolution* to serve as the light drillship, the Scientific Ocean Drilling Vessel (SODV), using $115 million in MREFC funds in FY 2005 through FY 2007. An initial period of *JOIDES Resolution* operations extended from June 2004 to January 2006; MREFC SODV shipyard conversion began in Fall 2006. Delivery of the rebuilt *JOIDES Resolution* to IODP is expected in November 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 16 European countries and 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 and South Korea are additional IODP participants; Australia and several potential additional Asian countries may join as partners 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.

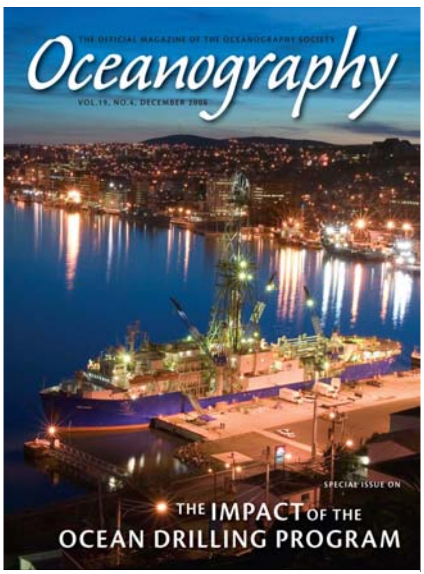
Principal Scientific Goals: The IODP scientific program is identified in the *IODP Initial Science Plan: Earth, Oceans and Life*, and includes emphasis on the following research themes:

- The Deep Biosphere and the Subseafloor 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, remote classroom broadcasts from the drillship, and having in service teachers sailing on drilling expeditions.



Evening falls on the Ocean Drillings Program's drillship *JOIDES Resolution* in St. Johns, Newfoundland, Canada. *Credit: Bill Crawford (Front cover of Oceanography Magazine, Vol. 19; No. 4, Dec. 2006)*

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. South Korea has joined as part of an emerging Asian Consortium, and negotiations for membership are underway with India and Australia.

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 Joint Oceanographic Institutions, Inc. (JOI) Alliance, a consortium of 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 Advisory Structure Executive Committee (SASEC, 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.

<u>Current Program Status and Future Program Planning</u>: 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 FY 2006. Future European-funded drilling is expected off of New Jersey on the U.S. east coast margin.

<u>Funding Profile</u>: All funding for the operation of the ODP has been provided through the R&RA account. FY 2005 to FY 2007 MREFC account funding supports the acquisition and outfitting of a drillship for use in the program. For more information on this project, please see the SODV 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 2004	-		35.75	$35.75
FY 2005	3.49		36.70	$40.19
FY 2006	3.63		28.56	$32.19
FY 2007 Request	2.00	21.30	4.50	$27.80
FY 2008 Request		33.36	4.64	$38.00
FY 2009 Estimate		35.03	4.77	$39.80
FY 2010 Estimate		36.78	4.92	$41.70
FY 2011 Estimate		38.62	5.06	$43.68
FY 2012 Estimate		40.55	5.40	$45.95
FY 2013 Estimate		42.58	6.00	$48.58

NOTE: Operations estimates for FY 2009 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 JOI, a consortium of major U.S. 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. The “JOI Learning” program (Teaching for Science; Learning for Life) can be viewed at www.joilearning.org. 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. An additional poster called “A Bolt from the Blue” shows several important aspects of methane hydrates that store methane gas in ocean sediments. 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 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 of student and teacher participation 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	160,000	9000	9500	27000
FY 2007 Estimate	180,000	10,000	10,500	35,000

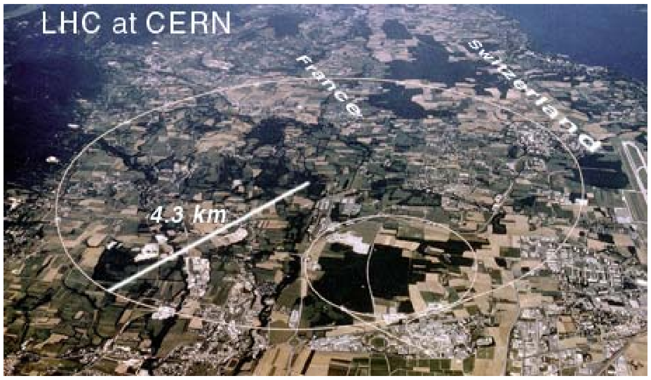
K-12 students is an estimate of students in classrooms with a teacher who was directly involved in IODP-supported education workshops or other activities targeted at K-12 educators.

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 more than 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 Arctic and Antarctic drilling research. Total funding for U.S. participation and analysis of samples and data is expected to reach approximately $30-35 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 underground particle accelerator that will accelerate tow counter-rotating beams of protons to 7,000 billion electron volts. The goal will be for protons from one beam collide with protons from the other. The accelerator is located on the border between France and Switzerland. *Credit: CERN* (www.atlas.ch/etours_accel/etours_accel03.html)

The LHC is an international project under construction at the CERN laboratory in Geneva, Switzerland. NSF awarded 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 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, are 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.

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 http://quarknet.fnal.gov). Many highly-trained students in high-energy physics move into industrial jobs.

LHC provides excellent opportunities for broadening participation of under-represented minorities in this energy frontier facility. In addition to students' participation on research grants, there are three noteworthy programs: (i) CHEPREO (Center for High Energy Physics Research and Education Outreach) lead by Florida International University, one of the largest Hispanic-serving U.S. institutions, creates a robust outreach activity based on CMS research, advanced networking, and LHC-related Grid computing infrastructure, creating pedagogic enhancements and teacher training; (ii) Center for the Study of the Origin and Structure of Matter, at Hampton University, an HBCU, which provides a strong graduate education program building upon Hampton's leadership role in U.S. LHC detector construction; and (iii) a large REU Site program at CERN with specific focus on involving African-American undergraduate students in the LHC research program.

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 PHY (in MPS) is responsible for day-to-day project oversight. The NSF program director also participates in an internal PAT, including staff from BFA (including the DDLFP), OGC, OLPA, OISE, 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.

FY 2007 Milestones: These focus on preparations for first collisions using both the ATLAS and CMS detectors.

US ATLAS
- Begin Trigger/DAQ support for operations with cosmic rays
- Receive ATLAS Approval of all U.S. ATLAS upgrade R&D tasks
- Release final version of software before first collisions
- Complete installation of muon system
- All U.S. ATLAS Detector Systems Operating
- Close ATLAS Beam Pipe
- Five Tier 2 Computing Facilities in Full Operation

US CMS
- Install DAQ from underground halls to surface
- Submit addenda to Physics Technical Design Report
- Complete Installation and cabling of tracker in underground hall
- Ensure CMS ready to close for beam
- Tier 0, 1, and 2 Computing Systems Operational (pilot run capacity)
- Receive pixel tracker at surface hall and ready for installation

<u>FY 2008 Milestones</u>: These focus on commissioning and data taking with both the ATLAS and CMS Detectors.

US ATLAS
- Complete first ATLAS Collisions at 0.9 TeV
- Finish installation of Trigger and Data Acquisition system
- Complete first ATLAS Collisions at 14.0 TeV

US CMS
- Complete first CMS Collisions at 0.9 TeV
- Complete installation of Pixel Tracker
- Operate Tier 0, 1, and 2 Computing Systems (low luminosity capacity)
- Complete first CMS Collisions at 14 TeV

<u>Funding Profile</u>: Funding for the overall LHC project, including the ATLAS and CMS detectors and the accelerator, is provided through an international partnership involving NSF, DOE, and the CERN member states, with CERN member states providing the major portion. Other countries that are not member states are also participating.

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					7.00		7.00	-	$7.00
FY 2005					10.51		10.51	-	$10.51
FY 2006					13.36		13.36	-	$13.36
FY 2007 Request					18.00		18.00	-	$18.00
FY 2008 Request					18.00		18.00	-	$18.00
FY2009 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
FY 2013 Estimate					18.00		18.00	-	$18.00
Subtotal, R&RA	$10.29		$0.15		$161.87		$172.31		
Subtotal, MREFC		-		$80.85		-		$80.85	
Total, Each Stage		$10.29		$81.00		$161.87			$253.16

NOTE: The estimated operational lifespan of this project is approximately 20 years. NSF and DOE jointly provide the U.S. share of Operations and Maintenance funding for the LHC ATLAS and CMS detectors, as was done for construction. For FY 2002 and earlier, R&RA funds totaling $4.59 million for Concept/Development were listed under Operations and Maintenance in the Budget Requests for FY 2006 and earlier. This has been corrected in the present table. Operations and maintenance estimates for FY 2012 are for planning purposes only and may not reflect actual budget requirements.

The total U.S. contribution to the construction project was $531 million, with $450 million from DOE and $81 million from NSF. NSF and DOE jointly provided a total contribution of $331 million for the detector construction, while DOE provided 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.

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

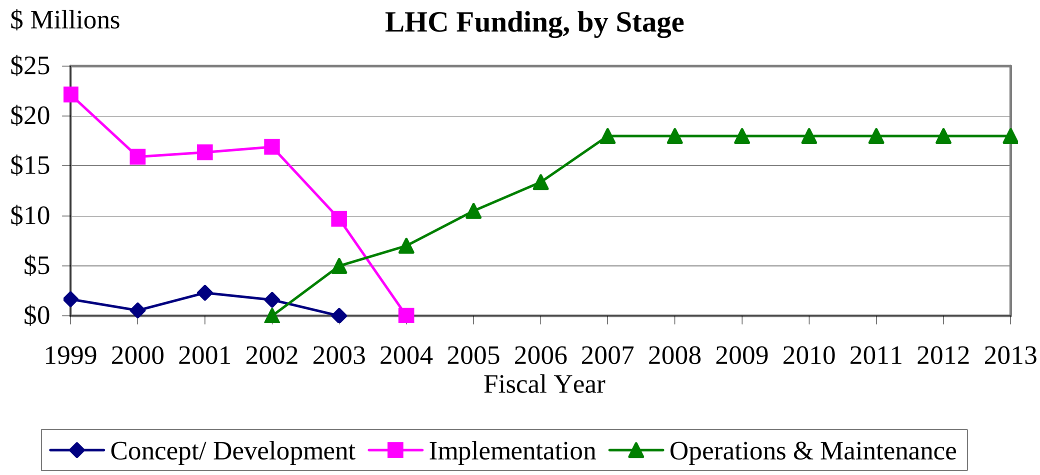
- Concept/Development: The LHC concept has been under discussion since FY 1989. NSF funding in FY 1996-99 supported technical design studies prior to the initiation of construction in FY 1999.

- Implementation: NSF components of the ATLAS and CMS detectors, constructed with funds provided FY 1999-2003, were originally 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. 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, which allows university scientists and students to participate in LHC research as well as other projects. Estimated funding for FY 2007 and beyond reflects NSF's 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.

This is the underground tunnel of the Large Hadron Collider (LHC) accelerator ring, where the proton beams are steered in a circle by magnets. The LHC is the accelerator facility (in France and Switzerland) which will contain the ATLAS and CMS detectors. *Credit: CERN* (www.atlas.ch/etours_accel/etours_accel01.html)

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.



<u>Science Support</u>: 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 awards to individuals 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)

LIGO Livingston Observatory, Livingston Louisiana. *Credit: LIGO Laboratory.*

Project Description: Einstein's theory of general relativity predicts that cataclysmic processes involving extremely dense objects in the universe will produce gravitational radiation. 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 distances between test masses at the ends of the arms caused by a passing gravitational wave. The predicted distortion of 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 x 10^{-18} 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 terrestrial constraints. Looking for coincident signals in all the interferometers simultaneously increases the likelihood for gravitational wave detection. LIGO is currently operating at better than its design specifications. The Advanced LIGO (AdvLIGO) upgrade, designed to reach optimal sensitivity for an earth-based instrument, is requested to begin construction in FY 2008. For more information on AdvLIGO, see the 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, not only from a host of cataclysmic cosmic phenomena but from the Big Bang itself, we have never detected a gravitational wave nor measured its waveform.

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

Principal Education Goals: LIGO has been a significant source of highly trained Ph.D. graduates for the country's workforce. The number of graduate students has grown from the beginning of LIGO's science runs in FY 2002 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, and it was dedicated in November FY 2007.

LIGO is committed to broadening participation. Both facilities are located near large populations of underrepresented minorities. Southern University, the largest HBCU, is heavily involved in LIGO research, with faculty and students able establish strong research programs; and LIGO has been able to partner with SU in their outreach program to reach to the larger African-American community. The LIGO Hanford facility is located in a region with large Hispanic and Native American population, and through laboratory outreach programs and visitor programs, has been able to interest students and teachers from K-12 schools and from local colleges and universities from those communities in the forefront science of LIGO and in science and mathematics generally.

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 has recently cooperated 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 PHY in MPS, who also participates in the Physics Division PAT, comprising staff from the OGC, OLPA, BFA (including the DDLFP), and OISE.

LIGO Hanford Observatory, Hanford, Washington. *Credit: LIGO Laboratory.*

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 two of design sensitivity. The LIGO facility in Livingston Parish, LA, suffered only very minor damage from Hurricane Katrina.

The mission-defining S-5 science run, which began on November 4, 2005, and is expected to last for eighteen months, has already attained a sensitivity approximately 40 percent better than the design goal. The FY 2008 request for LIGO operations is \$28.20 million. This funding level, which is less than the \$33.0 million requested for FY 2007, assumes that the AdvLIGO construction project will start in FY 2008 and that some LIGO personnel will be diverted to that project.

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 (R&RA)	Implementation		Operations & Maintenance (R&RA)	Totals		Grand Total
		R&RA	MREFC		R&RA	MREFC	
FY 2004 & Earlier	47.56	35.90	236.00	33.00	116.46	236.00	$352.46
FY 2005				32.00	32.00	-	$32.00
FY 2006 Actual				31.68	31.68	-	$31.68
FY 2007 Request				33.00	33.00	-	$33.00
FY 2008 Request				28.20	28.20	-	$28.20
FY 2009 Estimate				27.60	27.60	-	$27.60
FY 2010 Estimate				27.80	27.80	-	$27.80
FY 2011 Estimate				29.20	29.20	-	$29.20
FY 2012 Estimate				32.20	32.20	-	$32.20
FY 2013 Estimate				36.00	36.00	-	$36.00
FY 2014 Estimate				42.90	42.90	-	$42.90
Subtotal, R&RA	$47.56	$35.90		$353.58	$437.04		
Subtotal, MREFC			$236.00			$236.00	
Total, Each Stage	$47.56		$271.90	$353.58			$625.48

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 were developed strictly for planning purposes. A recent cost and schedule baseline review may result in modifictions to these numbers, once the results have been through the standard NSF processes. 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 – $11.6.0 million (FY 1975-87); pre-construction R&D – $16.0 million (FY 1988-91); and ongoing R&D throughout construction – $20.0 million (FY 1992-98).

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

- Management and Operations: LIGO 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 2015 are the same as those shown for AdvLIGO in the MREFC section.

Renewal or Termination: NSF extended the cooperative agreement for the support of LIGO operations, which was to expire at the end of FY 2006, 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 at each site 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 Science Education Center at the Livingston, LA site that will be filled with Exploratorium exhibits. The Center, which was dedicated in November 2006, is the focal point for augmenting teacher education at Southern University and hosts other student-teacher activities state-wide through the Louisiana Systemic Initiative Program. Outreach coordinators have 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 $5.5 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 more than 40 collaborating institutions with over 500 participating scientists. An 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.

Major Research Equipment and Facilities Construction Projects

The MREFC account supports the acquisition, construction and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Projects supported by this account are intended to extend the boundaries of technology and open new avenues for discovery for the science and engineering community. Initial planning and design, and follow on operations and maintenance costs of the facilities are provided through the 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 highest priority in FY 2008 is to continue to fund the Alaska Region Research Vessel ($42.0 million), the Atacama Large Millimeter Array ($102.07 million), the IceCube Neutrino Observatory ($22.38 million), the National Ecological Observatories Network ($8.0 million), the Ocean Observatories Initiative ($30.99 million), and the South Pole Station Modernization project ($6.55 million).

NSF is requesting funding for one new start in FY 2008: Advanced LIGO ($32.75 million). For additional information on all 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 NHMFL is committed to broaden the participation of the user base and make its facilities 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 with special emphasis on broadening the participation to include women and minorities currently underrepresented in science, mathematics, and engineering. 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 6600 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.

According to the NHMFL's web site, www.magnet.fsu.edu/collaborations/, the Laboratory is collaborating with the "U.S. Navy, FSU, the FAMU-FSU College of Engineering, and numerous private sector partners to develop advanced power systems that will support the Navy's all-electric ship program. This R&D effort for the next-generation of ship propulsion is expected to have broad applications in aerospace, commercial industry, and electric utilities."

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 900 MHz Ultra-Wide Bore Magnet, one of the most powerful superconducting magnets on the planet, capable of creating a magnetic field of 21 tesla (about .5 million times the strength of the Earth's magnetic field). *Credit: NHMFL*

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.

The Laboratory has a diversity plan that is part of the cooperative agreement. The plan is updated and reviewed annually. As part of the plan the NHMFL has increased the diversity of its advisory committee. In addition, a newly established Diversity Advisory Committee reports directly to the Laboratory Director.

<u>Current Project Status</u>: 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 has now entered 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.

NSF renewed support for the NHMFL in 1996 and again in 2001 following comprehensive external reviews. The current cooperative agreement for the support of NHMFL operations was extended for 2 years with NSB approval, and will end in December 2007. Based on the recommendation of an external advisory panel, further support for the Laboratory will depend on the evaluation of a renewal proposal submitted to NSF in FY 2007.

The NSF FY 2007 Request for the NHMFL totals $26.50 million, including support for the National High Field Mass Spectrometry Facility from the Division of Chemistry. An additional $2.50 million in annual support is currently planned beginning in FY 2008; final support levels for FY 2008 and beyond will depend on the outcome of the review of the renewal proposal.

<u>Funding Profile</u>: 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	3.90	21.84	$25.74
FY 2007 Request	4.00	22.50	$26.50
FY 2008 Request	4.00	25.00	$29.00
FY 2009 Estimate	4.00	25.00	$29.00
FY 2010 Estimate	4.00	25.00	$29.00
FY 2011 Estimate	4.00	25.00	$29.00
FY 2012 Estimate	4.00	25.00	$29.00

The data are presented as being either implementation (permanent equipment) or operations and maintenance (including non-permanent equipment). Estimates for FY 2008 and beyond are dependent on the outcome of a 5 year renewal request to be reviewed in FY 2007.

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. Contingent on merit review, NSF plans to support the construction of the Series-Connected Hybrid (SCH). SCH will provide combined high DC field with high stability and high homogeneity at much lower power than current magnets. At the NHMFL/LANL, construction continued steadily on the NSF-DOE funded 100 T Multi-Shot Magnet. In FY 2006 DMR made a Conceptual Design Award to Johns Hopkins University for a high-field magnet for neutron scattering experiments at the Spallation Neutron Source.

The NHMFL's Ion Cyclotron Resonance (ICR) Program supports a 14.5 Tesla Fourier Transform-Ion Cyclotron Resonance (FT-ICR) mass spectrometer to address 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 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 hosted 15 females, 6 Hispanics and 6 African-Americans among the 37 REU students in the 2005 and 2006 programs. In FY 2006 NHMFL was awarded $122,057 to continue a Research Experiences for Teachers (RET) activity in FY 2006. The Laboratory's diversity plan anticipates increased accessibility for minorities to the REU/RET programs. In addition, ongoing partnerships with HBCUs and other minority institutions will be strengthened.

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 7,000 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	7,000	20	22	200
FY 2006[d]	7,000	17	3	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 2006 number of students receiving PhDs 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 2006, the NHMFL at FSU supported an average of 97 graduate students, 33 postdoctoral research associates, and 25 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 NationaleNanotechnology 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.

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 and help stimulate technological innovation in diverse domains of nanoscale science and engineering. The network also develops the infrastructure and intellectual 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, 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 individual Site Directors and 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 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 NSF. The Site Directors are responsible for local management functions of 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, which requires annual site reviews held at one of the network sites. In addition, a semi-annual review is held at NSF attended by the Network Director, Site Directors, and area coordinators. The program officer for the NNIN activity resides in the Division of Electrical, Communications, and Cyber Systems (ECCS) 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 nine months of operation at the Georgia Institute of Technology node in December 2004. The second annual review was held at the University of Texas, Austin node in February 2006. Due to continuity provided by the five sites in the previous National Nanofabrication Users Network (NNUN), and to the credit of the NNIN management team, the network 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; continued improved performance at new sites with good plans in place to make them fully functioning nodes with solid user bases, including external users; and impressive network-wide efforts on educational outreach and societal and ethical implications of nanotechnology.

Funding Profile: The first three years of funding were $13.80 million in FY 2004 and FY 2005 and $14.43 million in FY 2006. The FY 2008 Request is $13.89 million, equal to the FY 2007 Request of $13.89 million. Primary funding for NNIN is provided by ENG; additional funding is provided by all the Directorates in the R&RA account. The Directorate for Education and Human Resources provides support for NNIN through the Advanced Technology Education program.

NNIN Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 2004		13.80	$13.80
FY 2005		13.80	$13.80
FY 2006		14.43	$14.43
FY 2007 Request		13.89	$13.89
FY 2008 Request		13.89	$13.89
FY 2009 Estimate		13.90	$13.90
FY 2010 Estimate		14.00	$14.00
FY 2011 Estimate		14.10	$14.10
FY 2012 Estimate		14.20	$14.20
FY 2013 Estimate		14.30	$14.30

NOTE: Data in FY 2004-2008 does not include support provided through the Advanced Technological Education program in the Directorate for Education and Human Resources. Estimates for FY 2009 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 the latest annual reporting period, extrapolated over the last three months, to cover March 2006-February 2007. The cumulative number of users for all 13 NNIN sites is 4,625, a 12% increase over the previous reporting year. This includes 3,473 academic users, 448 small company users, and 222 large company users. Academic users includes undergraduates, graduates, postdoctoral associates, and faculty, but is primarily graduate students. Approximately 1,000 graduate students earning PhD awards each year depend on NNIN facilities to conduct an important part of their research. Over

1,700 scholarly publications have resulted and over $400 million in research investment nationwide is leveraged by use of NNIN facilities.

Renewal or Termination: The current award expires at the end of FY 2008. It 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 FY 2005, 81 undergraduate students participated in the REU program primarily with use of NSF supplemental REU site funds and other agency resources. In FY 2006, due to lack of these supplemental resources and the need to rely on NNIN site funds, the number of REU students was reduced to 64.

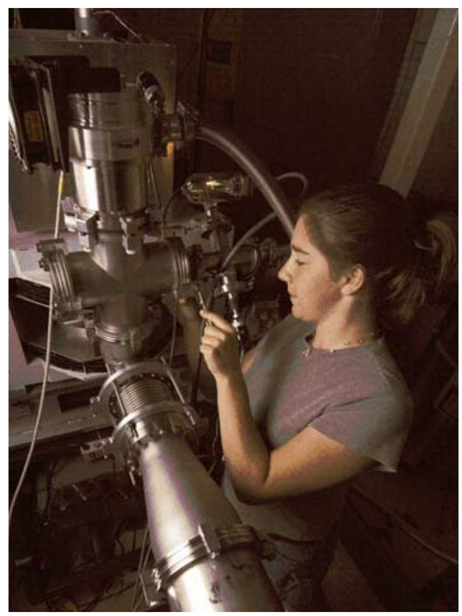
Science Support: NSF and other agencies independently award research grants to principal investigators who may use the NNIN facilities to carry out some aspects of their research projects.

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.



A graduate student prepares the beta-Nuclear Magnetic Resonance apparatus for an experiment with rare isotopes. While the general methods employed in beta-NMR are the same as used today in medical applications of Magnetic Resonance Imaging, experiments with rare isotopes are up to 14 orders of magnitude more sensitive by detecting the emitted beta particle, when the rare isotope decays. *Credit: NSCL at Michigan State University*

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.

About 50 undergraduate students are presently also involved in research, 16 of whom are women. Since 2002, there have been a total of 103 graduate students, of whom 17 are women and three are African American. The laboratory has also recently launched additional efforts to broaden participation by under-represented groups at all levels, beginning with the appointment of an external advisory panel for diversity matters, and leading to the development of a formal diversity plan.

Current Project Status: An experimental program using the coupled cyclotron facility is now underway. The FY 2008 Request for the NSCL totals $19.50 million, a $1.90 million increase over the FY 2007 Request of $17.60 million. 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		17.50	$17.50
FY 2006		17.34	$17.34
FY 2007 Request		17.60	$17.60
FY 2008 Request		19.50	$19.50
FY 2009 Estimate		20.50	$20.50
FY 2010 Estimate		21.00	$21.00
FY 2011 Estimate		21.50	$21.50
FY 2012 Estimate		21.50	$21.50
FY 2013 Estimate		21.50	$21.50

Operations numbers for FY 2008-2011 reflect the results of the review process and NSB-approved NSF recommendations for a new Cooperative Agreement. Numbers for FY 2012-2013 will be determined at a later date.

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.

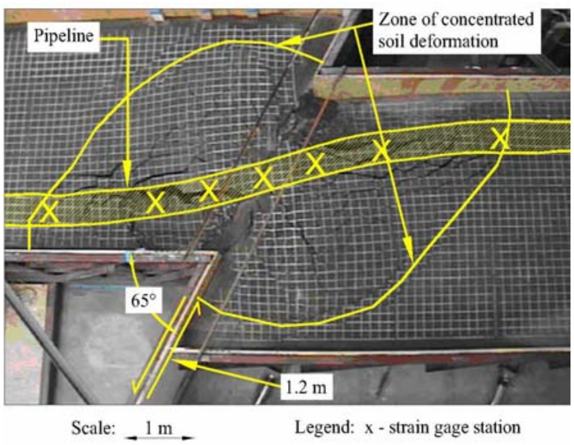
Renewal or Termination: On the basis of ad-hoc and site reviews, NSF staff have implemented a new Cooperative Agreement that was recently approved by the National Science Board.

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 multimedia "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 Cornell University, using the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES), conducted the largest laboratory experiments ever performed of ground rupture effects on underground pipelines and duplicated what would happen to real pipelines at active, moving faults. This image shows an overhead view of a large-scale ground rupture test on a 400-mm-diameter plastic pipeline composed of high density polyethylene (HDPE). *Credit: N. Olson, Cornell University*

Principal Scientific Goals: NEES's broad-based national research facilities and cyberinfrastructure enables new discovery and knowledge through capabilities to 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. NEESinc 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: 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 and are sources of federal partnerships. 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 an MOU, and in September 2005, NSF and the Japanese Ministry of Education, Culture, Sports, Science, and Technology signed the Memorandum Concerning Cooperation in the Area of Disaster Prevention Research. In March 2006, researchers from 19 countries convened in San Francisco, CA, for the first World Forum to discuss sharing expertise and coordination in earthquake engineering testing and cyberinfrastructure.

Management and Oversight: 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 are 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).

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, which included four new capabilities for system integration (cyberinfrastructure), completed in September 2005, and new capabilities at 13 experimental facilities, which were completed in FY 2006.

Through three annual program solicitations and Small Grants for Exploratory Research, CMMI has funded 33 research projects to utilize the NEES facilities. In FY 2008, $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 (EPSCoR) through the Education and Human Resources (EHR) account. NSF plans to provide $22.17 million to NEES for operations and maintenance in FY 2008.

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						21.03		$21.03	-	-	**$21.03**
FY 2007 Request						21.27		$21.27	-	-	**$21.27**
FY 2008 Request						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						23.60		$23.60	-	-	**$23.60**
FY 2013 Estimate						24.19		$24.19	-	-	**$24.19**
Subtotal, R&RA	$0.70		$0.00			$200.36		$201.06			
Subtotal, MREFC		$0.39		$81.37			$0.00		$81.76		
Subtotal, EHR					$1.10					$1.10	
Total, Each Stage		**$1.09**			**$82.47**		**$200.36**				**$283.92**

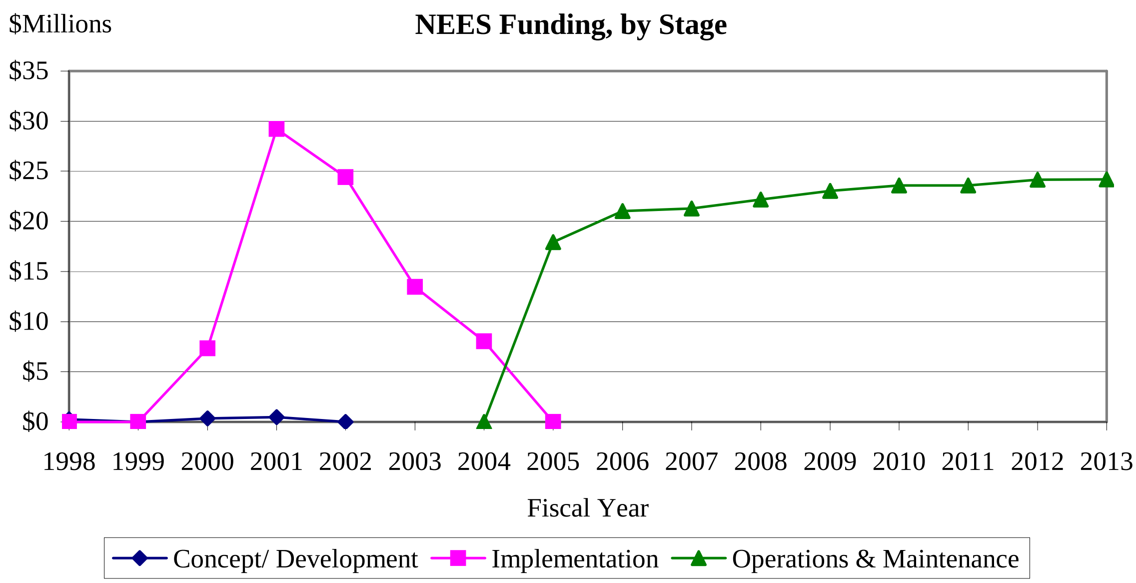
NOTE: The expected operational lifespan of this project is 10 years, from FY 2005 to FY 2014. NEES operations for FY 2005 – FY 2009 was approved by the National Science Board in May 2004 for up to $106.52 million total; approximately $21.3 million annually. Operations estimates for FY 2010 and beyond 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 earthquake engineering community, both within the U.S. and abroad. During FY 2006, NEESinc maintained 93% of its planned functional facility days at the 15 experimental facilities. 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.



<u>Renewal or Termination</u>: 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.

<u>Science Support</u>: 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, individual investigator, and payload 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 2008.

POLAR FACILITIES AND LOGISTICS

Polar Facilities

Project Description: The Operations and Science Support program within the Division of Antarctic Infrastructure and Logistics provides 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 transportation, facilities, communications, utilities (water and power), and health and safety infrastructure. The U.S. Antarctic Program (USAP) also provides environmental stewardship and maintains the U.S. presence in Antarctica in accordance with U.S. policy.

Partnerships and Connections to Industry: There are many separate subcontractors for supplies and technical services. The Office of Polar Programs contracts with a prime support contractor for science support, operations, and maintenance of the Antarctic stations and related infrastructure in New Zealand and Chile, and leasing of research vessels. The contractor is selected through a competitive bidding process. The current Antarctic support contract was recompeted and awarded to Raytheon Polar Services Corporation (RPSC) in FY 2000. After a five-month phase-in period, RPSC 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.

South Pole residents walk near the cargo buildings at Amundsen-Scott South Pole Station in late March, the day before the annual sunset. The temperature on this particular day was minus 60 degrees Fahrenheit. As Austral Winter approaches, the Sun remains below the horizon for longer and longer periods of time until winter officially sets in. The next sunrise won't occur until September 21. During the six months of darkness that is the austral winter, temperatures will drop to minus 100 degrees Fahrenheit. *Credit: Brien Barnett, NSF*

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.

Management and Oversight: OPP has overall management responsibility for Operations and Science Support. OPP evaluates the performance of RPSC every year via a Performance Evaluation Committee and an Award Fee Board that includes representatives from OPP and the Office of Budget, Finance, and Award Management (BFA). The Operations and Science Support program in the Division of Antarctic Infrastructure and Logistics also provides oversight and direction of the South Pole Station Modernization (SPSM) project, an activity funded out of the Major Research Equipment and Facilities Construction (MREFC) account since FY 1998. Since FY 2006, NSF has been responsible for funding the operation and maintenance of the U.S. Coast Guard’s (USCG) three polar icebreakers. The agencies cooperate under a Memorandum of Agreement that includes guidance for planning and scheduling. It sets forth the terms and conditions for reimbursement to the USCG from NSF. NSF and the USCG work together to formulate operations and maintenance plans and associated funding requirements. NSF is responsible for ascertaining the needs of other federal agencies and for securing USCG program plans for accommodating them, on a reimbursable funding basis. OPP's performance is reviewed externally by Committees of Visitors and the OPP Advisory Committee (OPPAC).

Current Project Status: All facilities (stations, research vessels and field camps) are currently operating normally. The poor condition of the USCG polar icebreakers, the Polar Star and the Polar Sea, and the uncertainty regarding their future prompted OPP and the OPPAC to identify and study options for reducing demands on the ship-based logistics system. OPP and the OPPAC are in the process of developing contingency plans for dealing with a possible failure of that system.

Funding Profile: NSF is requesting $230.14 million in FY 2008 for Polar Facilities to provide infrastructure critical to supporting International Polar Year (IPY) activities as well as continued support for research projects in the Antarctic. All funding for polar facilities, excluding support for the SPSM MREFC project, is provided through the R&RA account. Support for SPSM is discussed in the MREFC chapter.

Polar Facilities
(Dollars in Millions)

	Antarctic Operations & Science Support		
	Implementation	Operations & Maintenance	Total, NSF
FY 2001		117.96	$117.96
FY 2002		126.15	$126.15
FY 2003		141.43	$141.43
FY 2004		147.04	$147.04
FY 2005		155.73	$155.73
FY 2006 Actual		196.45	$196.45
FY 2007 Request		218.09	$218.09
FY 2008 Request		230.14	$230.14
FY 2009 Estimate		235.89	$235.89
FY 2010 Estimate		241.79	$241.79
FY 2011 Estimate		247.84	$247.84
FY 2012 Estimate		254.03	$254.03
FY 2013 Estimate		260.38	$260.38

NOTE: Estimates for FY 2009 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 Operations & Science 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.

Renewal or Termination: NSF will not terminate support for the facilities themselves, such as McMurdo station or South Pole Station. U.S. policy directs NSF to maintain an active and influential presence in Antarctica, including year-round occupation of South Pole Station and two coastal stations.

Polar Logistics

Project Description: Polar Logistics consists of two activities: the U.S. Antarctic Logistical Support Activities program within the Division of Antarctic Infrastructure and Logistics, and the Research Support and Logistics program within the Arctic Sciences Division.

Partnerships and Connections to Industry: There are many separate subcontractors for supplies and technical services.

A worker at Admundsen-Scott South Pole station waves goodbye to an LC-130 military aircraft as it departs the station with approximately 35 employees who had "wintered over" (spent the winter) at the bottom of the world. The flight was the first of several to transport groups of residents home from the Antarctic. *Credit: USAP/NSF; Photo by Mark Buckley, RPSC (2001)*

The U.S. Antarctic Logistical Support Activities program funds support provided by the U.S. Department of Defense (DoD). The DoD operates as a primary logistical support provider on a cost-reimbursable basis. Major funding elements of DoD support include: military personnel, LC-130 flight operations, maintenance, and facilities support of the 109th Airlift Wing (AW) of the New York Air National Guard in Scotia, New York and Antarctica; transportation and training of military personnel supporting the U.S. Antarctic Program; 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; bulk fuel purchased from the Defense Logistics Agency; and reimbursement for use of DoD satellites for communications.

The Research Support and Logistics program in the Arctic Sciences Division is driven by and responds to science supported by the Division. Funding 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 (UNOLS) vessels and coastal boats; 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.

Management and Oversight: OPP has overall management responsibility for U.S. Antarctic Logistical Support Activities and Arctic Research Support & Logistics. OPP's performance is externally reviewed by Committees of Visitors and the OPP Advisory Committee.

Current Project Status: All facilities (stations, research vessels and field camps) are currently operating as normal.

Funding Profile: All funding is provided through the R&RA account. Support provided by DoD for the U.S. Antarctic Logistical Support Activities program remains at $67.52 million in FY 2008. NSF is requesting $43.60 million for Arctic Research Support and Logistics in FY 2008 to provide infrastructure critical to supporting IPY activities as well as continuing support for research projects throughout the Arctic.

Polar Logistics
(Dollars in Millions)

	U.S. Antarctic Logistical Support Activities		Arctic Research Support & Logistics		
	Implementation	Operations and Maintenance	Implementation	Operations and Maintenance	Total, NSF
FY 2001		68.16		25.40	$93.56
FY 2002		70.27		27.58	$97.85
FY 2003		68.55		30.29	$98.84
FY 2004		67.54		37.39	$104.93
FY 2005		70.26		35.06	$105.32
FY 2006 Actual		66.66		31.15	$97.81
FY 2007 Request		67.52		44.90	$112.42
FY 2008 Request		67.52		43.60	$111.12
FY 2009 Estimate		67.52		44.69	$112.21
FY 2010 Estimate		67.52		45.81	$113.33
FY 2011 Estimate		67.52		46.95	$114.47
FY 2012 Estimate		67.52		48.13	$115.65
FY 2013 Estimate		67.52		49.33	$116.85

NOTE: Estimates for FY 2009 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

Renewal or Termination: NSF will not terminate support for the facilities themselves.

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.

The gregorian dome and its suspension structure over the main deflector of the Arecibo radio telescope, at night. *Credit: Arecibo Observatory/NSF*

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

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

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

Management and Oversight: Management is through a cooperative agreement with Cornell University. Oversight is through detailed annual program plans and long range plans for NAIC, plus bi-weekly teleconferences with the NAIC director and annual reports that are submitted to NSF. NSF conducts periodic reviews of Cornell management by external committees. Ongoing oversight and evaluation is by an assigned NSF program director in the Division of Astronomical Sciences (AST) in the Directorate for Mathematical and Physical Sciences (MPS) and in consultation with community representatives. Arecibo Visiting Committee meetings (commissioned by Cornell) are attended by the NSF program manager, and committee reports are made available to NSF. All AST-funded facilities have established policies and practices designed to broaden the participation of individuals from under-represented groups among their scientific and technical workforce.

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 until March 31, 2010.

Funding Profile: All funding for NAIC to date has been provided through the R&RA account. Funding amounts for FY 2008 and beyond include consideration of the implementation of the recommendations of the Senior Review of the Astronomy Division (AST) portfolio. The FY 2008 Request for NAIC totals $12.15 million, with $10.45 million from AST and $1.70 million from the Division of Atmospheric Sciences (ATM) in the Directorate for Geosciences.

NAIC Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF[1]
FY 2002		11.06	$11.06
FY 2003		12.73	$12.73
FY 2004		12.33	$12.33
FY 2005		12.22	$12.22
FY 2006		12.15	$12.15
FY 2007 Request		12.16	$12.16
FY 2008 Request		12.15	$12.15
FY 2009 Estimate		11.27	$11.27
FY 2010 Estimate		9.67	$9.67
FY 2011 Estimate		5.67	$5.67
FY 2012 Estimate		5.67	$5.67

[1]Total budget includes funding from both MPS/AST and GEO/ATM. In FY 2008, $10.45 million is planned from AST and $1.70 million from ATM. See narrative below for discussion of FY 2008 and outyear projected budgets.

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

- Budget Explanation: Funding levels for FY 2008-2010 reflect a staged reduction in AST funding from $10.46 million in FY 2007 to $8.0 million in FY 2010 as recommended by the Senior Review of the AST facilities portfolio, with an assumption of constant ATM funds of $1.70 million per year. Funding to paint a part of the telescope, estimated at $3.2 million, is included in these estimates.

  The Senior Review recommendation calls for the observatory to reduce its scientific scope and operational complexity by focusing primarily on survey operations with a new multi-feed receiver, with suspension of all new instrumentation development. The concomitant reductions in staffing levels for both engineering and scientific support provide the recommended cost savings. Budgets for 2011 and 2012 incorporate a further reduction to $4 million per year from AST as recommended by the Senior Review; additional funding, with sources yet to be determined, will be required in order to provide adequate support for the facility.

- 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. A $25 million upgrade, jointly funded by NSF and NASA, was completed in 1997 and included 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. A mid-term management review will be held in March of 2007. A decision on termination of the facility will be undertaken in the 2010 timeframe.

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. All facility educational and outreach activities seek to broaden participation by under-represented groups. The AST-supported facilities provide forefront research capability and opportunities for access that enable faculty and students from under-represented groups and at diverse institutions to develop and carry out competitive research programs.

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: The National Center for Atmospheric Research is a federally funded research and development center (FFRDC) serving a broad research community, including atmospheric scientists and researchers in complementary areas of the environmental and geosciences. Facilities available to university, NCAR, and other researchers include world-class supercomputing 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, atmospheric sounding, and other surface sensing systems are available for atmospheric research. NCAR operates 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 an 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 operates scientific research programs that include the following areas: studies of large-scale atmospheric and ocean dynamics that contribute to an understanding of the past and present climate processes and global climate change; 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 their 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 further supports the scientific community by providing fellowships, internships, workshops, and colloquia for students and visiting scientists.

Principal Education Goals: NCAR disseminates knowledge of the geosciences to the general public, K-12 schools, teachers and students, undergraduate and graduate institutions, 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 NCAR's 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 serve 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 47 years. Notable examples include the joint development of community models and extensive collaboration with university partners and 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 70 Ph.D. granting academic institutions. 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 (in GEO) along with the Division of Acquisitions and Cooperative Support (DACS), provide oversight of NCAR and the cooperative agreement with UCAR for its management.

NSF's Gulfstream V jet, operated by NCAR, made its first flight during the Terrain-Induced Rotor Experiment (T-Rex). Scientists aboard will collect data at the tops of storms and lower edge of the stratosphere, altitudes out of reach of most research aircraft. The aircraft's range will enable scientists to survey remote ocean regions in a single flight to learn more about interactions between the oceans and atmosphere. *Credit: UCAR*

Current Project Status: The NCAR strategic plan, "NCAR as Integrator, Innovator and Community Builder," was completed in FY 2006. The plan sets outs the mission, core values and strategic goals that guide NCAR science. In working towards these goals, NCAR will seek to support the scientific community in explaining how the Earth system functions and accurately predicting how it is likely to evolve, providing robust, accessible, and well-integrated information services and tools for research, analysis, and education. By connecting strategic goals, plans, and accomplishments, the NCAR annual report (http://www.nar.ucar.edu/) provides a summary of the full life-cycle of the research, facilities, and educational activities that have taken place in FY 2006.

In addition, NCAR has managed the acquisition, modification and instrumentation of the the High-Performance Instrumented Airborne Platform for Environmental Research (HIAPER) through the MREFC account, which is now also operated and maintained by NCAR. A highly modified and FAA certified Gulfstream G-V aircraft, HIAPER began full scientific operations research during the first quarter of calendar year 2006. Operation of HIAPER is estimated at approximately $5.0 million annually; and it enables, in any given year, approximately $20 million in NSF funded science proposals.

NCAR Funding Profile: All funds for NCAR during this time frame, excluding construction funding for HIAPER, have been provided through the Research and Related Activities (R&RA) Account.

NCAR Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 2004	4.61	78.31	$82.92
FY 2005	4.73	75.31	$80.04
FY 2006	4.85	79.66	$84.51
FY 2007 Request	4.97	81.88	$86.85
FY 2008 Request	5.00	85.87	$90.87
FY 2009 Estimate	5.10	86.00	$91.10
FY 2010 Estimate	5.10	87.00	$92.10
FY 2011 Estimate	5.22	89.00	$94.22
FY 2012 Estimate	5.23	91.00	$96.23
FY 2013 Estimate	5.23	91.00	$96.23

NOTE: MPS contributions for statistics and modeling are included. Operations estimates for FY 2009 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: These costs represent expenditures for major equipment purchases and activities which go beyond simple maintenance and involve significant refurbishment or renovation of assets such as buildings and office space. Since FY 1999, a project to refurbish the Mesa Lab building located in Boulder, CO, has been the single largest component of this category. In 2007 and 2008, refurbishment of the taxi way and access routes at the Jefferson County Airport (where NSF houses it's aircraft) to improve safety and functionality will be undertaken. Estimates beyond FY 2008 are based on historical funding needs.

- 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 operations, and maintenance amount is used to support science conducted by NCAR scientists.

Renewal or Termination: The cooperative agreement for the management of NCAR is currently being competed. The next agreement will be for the five years beginning FY 2009. Proposals will be subject to NSF's standard merit review procedures, with expert reviewers who are preeminent researchers and managers. In addition, a mid-award review of management of NCAR took place in March 2006, that produced favorable comments from the review panel and a set of constructive recommendations; funding levels beyond FY 2007 will be dependent on the implementation of the review panel's recommendations and on the continuous oversight provided by NSF.

Associated Research and Education Activities: NCAR employs a large number of scientists who pursue research objectives individually and in groups, and numerous external researchers use NCAR facilities to further their research objectives. NCAR has also recently created an expanded and updated visitor area with various hands-on displays for schoolchildren or citizens visiting the Mesa Laboratory. Lectures and demonstrations are provided for visiting students and teachers. In addition, UCAR'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 14.6 million user sessions in FY 2006 involving 125.4 million pages served.

The table below lists K-12 teachers and students coming to NCAR to attend workshops or learn about atmospheric sciences, and undergraduate and graduate students who arrive at NCAR for a temporary stay to do specific research that typically lasts three months to a year.

Direct Impact of NCAR's Participation in Education Activities

Year	K-12	Undergraduate	Graduate	Teachers
1997	7,067	*25*	*67*	32
1998	7,063	*26*	*68*	264
1999	9,569	*24*	*69*	90
2000	9,894	*24*	*69*	92
2001	8,995	*23*	*63*	101
2002	9,424	*67*	*57*	865 [a]
2003	7,295 [b]	*85*	*109*	815 [b]
2004	8,505	*81*	*125*	1,381
2005	13,723 [c]	*92*	*189*	1,510
2006	15,215 [c]	*54*	*200*	*1,200*

NOTE: Numbers in italics are estimates.
a The increased number of teachers in FY 2002 includes participants at a series of
b The decreased number in FY 2003 reflects partial closure of Mesa Lab facilities
c Includes public visits to Mesa Lab throughout year and special events: Super Science Saturday and 2 Wild Bear Science Saturdays, Earth Day: (4,500 attendance in FY 2006)

Science Support: NSF-supported researchers with grants totaling approximately $28 million per year used the aircraft and observational facilities operated by NCAR in FY 2006. 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 cross-directorate environmental research and education programs 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.

The Cerro Tololo Inter-American Observatory 4-meter telescope dome in June of 2006. *Credit: M. Urzúa Zuñiga/Gemini Observatory/NSF*

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, 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.

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. All AST-funded facilities have established policies and practices designed to broaden the participation of individuals from under-represented groups among their scientific and technical workforce. NSF conducts periodic reviews of AURA management by external committees. The most recent management review took place in August 2006; the panel endorsed AURA’s performance as excellent. Ongoing oversight and evaluation is by an assigned NSF program director in the Division of

Astronomical Sciences (AST) in the Directorate for Mathematical and Physical Sciences (MPS) and in consultation with community representatives.

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 was carried out in August 2006. In response to the favorable management review, AST will extend the current Cooperative Agreement with AURA for management of NOAO and NSO for one year, which will be through FY 2008. The additional year will provide time for NSF and AURA to incorporate the recommendations of the Senior Review into management of NOAO and NSO. The FY 2008 Request for base operations for NOAO is $26.88 million and for NSO is $11.30 million, for a total of $38.18 million, an increase of $3.63 million over the FY 2007 Request. This increase represents the net response to the recommendations of the AST Senior Review, which included (i) a one-time reinvestment in the infrastructure at Kitt Peak and Cerro Tololo, and (ii) reductions in several targeted programs

NSO is nearing the completion of the design and development phase for the Advanced Technology Solar Telescope (ATST), which entered the 'readiness' phase for MREFC funding in late FY 2005. Detailed reviews to assess its status with regard to inclusion in a future budget will be held in FY 2007. NOAO is also actively participating in the development of potential future infrastructure projects or funding opportunities such as 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 and other high-level studies.

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	2.00	0.36	34.55	$36.91
FY 2007 Request	4.00	1.50	34.55	$40.05
FY 2008 Request	5.00	0.00	38.18	$43.18
FY 2009 Estimate	5.00	0.00	38.18	$43.18
FY 2010 Estimate	5.00	0.00	38.18	$43.18
FY 2011 Estimate	5.00	0.00	38.18	$43.18
FY 2012 Estimate	5.00	0.00	38.18	$43.18
FY 2013 Estimate	5.00	0.00	38.18	$43.18

NOTE: The current cooperative agreement expires in FY 2007. Funding for FY 2008 reflects initial implementation of the recommendations of the AST Senior Review. Estimated budgets for FY2009 and beyond are indicative only. Actual annual requests will be formulated based on results of detailed cost reviews and implementation plans currently being developed for recommendations of the Senior Review.

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

- TSIP and AODP: The funding for the Telescope System Instrumentation Program (TSIP), a community instrumentation program developed to foster the system of large US public and private telescopes, is provided by NSF and administered through NOAO. TSIP funds 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. TSIP funding totals $5.0 million in the FY 2008 Request, an increase of $1 million over the FY 2007 Request. Funding for the projects in the Adaptive Optics Development Program, a similar community instrumentation program, will be complete in FY 2007. Future development in adaptive optics will be funded from AST's Advanced Technologies and Instrumentation program.

- 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 was carried out in August 2006, on the basis of which NSF has decided to renew the program. Funding amounts for FY 2008 include initial consideration of the recommendations of the Senior Review of the AST portfolio. Funding levels for future years will be based on results of detailed costs reviews and implementation plans currently being developed for recommendations of the Senior Review.

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). All facility educational and outreach activities seek to broaden participation by under-represented groups. The AST-supported facilities provide forefront research capability and opportunities for access that enable faculty and students from under-represented groups and at diverse institutions to develop and carry out competitive research programs.

Science Support: In addition to the funds listed above, approximately $270,000 per year is provided in total from 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, peer-review telescope allocation committees provide merit-based telescope time but no financial support. NSF does not provide awards targeted specifically for use of NOAO and NSO. Most users are supported through NSF or NASA grants to pursue scientific programs that require use of NOAO and NSO.

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. It 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 Atacama Large Millimeter Array (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 training for K-12 teachers. The primary educational 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.

The Green Bank Telescope (GBT) in West Virginia is the world's largest, fully steerable radio telescope. Described as a 100-meter telescope, the actual dimensions of the surface are 100 by 110 meters. The overall structure of the GBT is a wheel-and-track design that allows the telescope to view the entire sky above 5 degrees elevation. The track is level to within a few thousandths of an inch in order to provide precise pointing of the structure while bearing 7,300 metric tons of moving weight. *Credit: NRAO/AUI/NSF*

Partnerships and Connections to Industry: Numerous U.S. universities, NASA, foreign scientific and technical institutes and industrial vendors are partners. The development of new telescopes, instrumentation, and sensor techniques is completed in partnership with relevant industry, through competitive subawards to various large and small aerospace companies, radio antenna manufacturing firms, and specialized electronics and computer software companies.

Management and Oversight: Management is through a cooperative agreement with Associated Universities Incorporated (AUI). The NRAO director reports to the president of AUI. Oversight is through detailed annual program plans and long range plans for NRAO, plus monthly, quarterly, and annual reports submitted to NSF. All AST-funded facilities have established policies and practices designed to broaden the participation of individuals from under-represented groups among their scientific and technical workforce. 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 in consultation with community representatives.

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 ALMA, a millimeter/submillimeter interferometer, which was approved as a Major Research Equipment and Facilities Construction (MREFC) project by the National Science Board in winter 2001. NRAO is the U.S. implementing organization of the ALMA project.

Funding Profile: The FY 2008 Request for NRAO totals $52.74 million. The FY 2008 request includes an increase over the FY 2007 Request of $2.0 million, including a total of $8.22 million for early ALMA operations. All funding for NRAO to date, excluding construction funding for ALMA, 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	5.43	41.60	$47.03
FY 2006	5.44	45.30	$50.74
FY 2007 Request	5.84	44.90	$50.74
FY 2008 Request	4.32	48.42	$52.74
FY 2009 Estimate	4.32	50.93	$55.25
FY 2010 Estimate	4.32	51.11	$55.43
FY 2011 Estimate	1.00	54.43	$55.43
FY 2012 Estimate	-	55.43	$55.43
FY 2013 Estimate	-	55.43	$55.43

The current cooperative agreement expires in FY 2009. Estimated budgets for FY2009 and beyond are indicative only. Actual annual requests will be formulated based on results of detailed cost reviews and implementation plans currently being developed for recommendations of the Senior Review.

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 astronomical community. Basic research by in-house staff is less than 5 percent of the total budget. The budgets estimated for FY 2009 and beyond are indicative only. Budget levels will be formulated based on results of detailed cost reviews and implementation plans currently being developed for recommendations of the AST Senior Review.

- 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 $8.22 million in FY 2008.

Renewal or Termination: The present cooperative agreement was extended to the end of FY 2009 with approval by the NSB in December 2005. A management review was carried out in early FY 2007, on the basis of which NSF will decide whether to renew or recompete the program.

The Very Large Array (VLA), supported by NRAO and one of the world's premier astronomical radio observatories, 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 in diameter. The data from the antennas is combined electronically to give the resolution of an antenna 36km across, with the sensitivity of a dish 130 meters. *Credit: NRAO/AUI/NSF.*

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 VLA 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. All facility educational and outreach activities seek to broaden participation by under-represented groups. The AST-supported facilities provide forefront research capability and opportunities for access that enable faculty and students from under-represented groups and at diverse institutions to develop and carry out competitive research programs.

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 facilities. Many users are supported through NSF or NASA grants to pursue scientific programs that require use of NRAO.

Recent Highlights

Adjusting LIGO's Optical Beams. *Credit: LIGO Laboratory*

► **LIGO Comes of Age**: The Laser Interferometer Gravitational-Wave Observatory (LIGO) has met and exceeded its sensitivity design goal. One of the most advanced scientific instruments ever built, LIGO began its first run at better than its design sensitivity on November 4, 2005 and will collect data through April 2007. Gravitational waves are distortions in the fabric of space-time produced by the rapid motion of massive objects. Although predicted by Einstein's general theory of relativity, they have never been directly observed. They can pass unhindered through dust and gas that would block the passage of radio, light, and X-ray radiation. Because of this, their exotic origin, and their nature as traveling ripples in space-time, they will open a new window on phenomena occurring in the universe. In addition to revealing many previously unseen phenomena, LIGO's observations can lead to refinements in the theory of relativity and assist scientists in choosing among theories of the universe.

All three IODP drilling platforms will be operational in FY 2008. From left and clockwise, the light drill ship (U.S.), the heavy drill ship (Japan), and an example of a mission specific platform (Europe) used for Arctic drilling. *Credit: JOI*

► **The Integrated Ocean Drilling Program** (IODP), an international effort for which NSF is a lead agency, has recorded numerous scientific achievements in its initial phase (FY2004-2007). For example:

- IODP showed that the Arctic had a subtropical climate 55 million years ago, a fact with far-reaching implications for Earth's climate system.
- Drilling off the Cascades uncovered valuable new clues about how methane hydrates, rich in greenhouse gas and a potential source of energy, are linked to subseafloor life.
- Deep drilling into Pacific ocean crust recovered, for the first time, a coarse-grained rock called gabbro, confirming the idea that ocean crust forms from the cooling of molten magma at mid-ocean ridges.

IODP officials expect more fundamental accomplishments in FY 2008 when all three of the program's drilling platforms will be in operation. The Japanese drillship Chikyu, which started testing in December 2005, will begin scientific exploration deep into the Earth's crust, focusing on how large, tsunami-generating earthquakes are formed. Meanwhile, NSF will rebuild the "light" IODP drillship, dramatically improving the program's ability to study seafloor life, analyze recovered core from drilling operations, and link characteristics of core samples to Earth's past climate and internal processes. The ship will be lengthened by 32 feet, which will increase lab space by 50 percent; quadruple its ability to support temporary laboratories; and increase its stability to provide better coring capability in inclement weather.

► **A Magnet for Education and Learning:** While the National High Magnetic Field Laboratory in Tallahassee, Florida, is known throughout the world for research involving high magnetic fields, the lab also supports a rich variety of educational activities for students, teachers, and the general public. In summer 2005, 20 undergraduate students and 11 teachers participated in research experiences for undergraduates and teachers programs, 40 local teachers attended a four-day summer institute on scientific literacy, two summer Teachers in Residence created and then presented a teachers' workshop for the American Geophysical Union, and college bound high school students participated in the Regional Institutes for Math and Science research experience. Each year, NHMFL staff members conduct outreach activities with more than 7,000 K-12 students. The annual Open House regularly attracts more than 4,200 members of the general public, who come from neighboring states for the annual event. Collaborations are ongoing through local science museums and outreach centers, high school "externships" and high school science laboratory support.

Whether Magnet Lab staff takes the science to them or they come to the lab, thousands of elementary, middle and high-school students are touched by the lab's educational activities each year. *Credit: NHMFL*

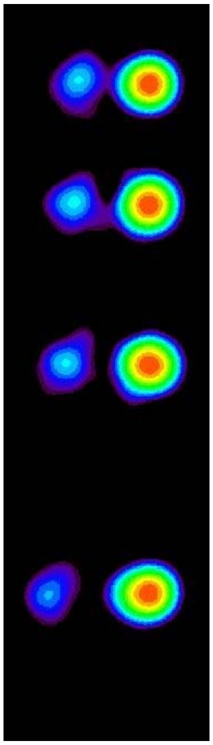
► **South Pole Proof of Concept: Traverse** On January 14, 2006, an NSF convoy returned to the U.S. base at McMurdo Station after a two-month, 2,056-mile overland journey to the South Pole and back. The successful traverse, the first over that route since the 1950's, was the culmination of a four-year effort to prove that NSF can resupply its Amundsen-Scott South Pole Station by ground as well as by air. This overland transport capability will remove two major engineering and logistical constraints—cargo size and weight—that have limited the design of large scientific instruments and infrastructure at the Pole. Until now, the only way in or out of the station was aboard an LC-130 transport aircraft. Everything from the large polar telescopes to the new South Pole station itself has had to be designed in individual sections that could be transported in an LC-130's cargo bay and then reassembled on site.

The Antarctic traverse arrived at the South Pole on Dec. 23, 2005. From left to right: Russ Magsig, lead heavy equipment mechanic; Greg Feleppa, equipment operator; Judy Goldsberry, heavy equipment operator; Richard "Stretch" Vaitonis, (holding flag) heavy equipment operator; John Wright (holding flag), project manager; Brad Johnson, heavy equipment operator; Tom Lyman, field safety, radar operator; John Van Vlack, heavy equipment mechanic. *Credit: Scott Jackson, NSF*

In the quest for a better way, traverses have set out in each of the past three years to cover steadily increasing distances between McMurdo and the Pole, encountering such difficulties as crevasse fields and enormous areas of soft snow that delayed their passage. This year, a crew of seven men and one woman guided their convoy of tracked vehicles out of McMurdo on Nov. 11, 2005, towing sleds of cargo, fuel and life-support modules. Six weeks later, after crossing numerous crevasse fields and ascending more than 9,300 feet from sea level to the top of the Polar Plateau, they arrived at the South Pole on Dec. 23, 2005, to deliver nearly 110 tons of cargo. The payload, which included two tractors, is equivalent to 11 loads of equipment and supplies aboard an LC-130.

► **Blazar Jets Push Closer to Cosmic Speed Limit** Astronomers using the National Science Foundation's Very Long Baseline Array (VLBA) have discovered jets of plasma blasted from the cores of distant galaxies at speeds within one-tenth of one percent of the speed of light, placing these plasma jets among the fastest objects yet seen in the Universe. “This tells us that the physical processes at the cores of these galaxies, called blazars, are extremely energetic and are capable of propelling matter very close to the absolute cosmic speed limit,” said Glenn Piner of Whittier College in Whittier, California. Piner worked on the project with student Dipesh Bhattari, also of Whittier College, Philip Edwards of the Japan Aerospace Exploration Agency, and Dayton Jones of NASA's Jet Propulsion Laboratory.

According to Einstein's Special Theory of Relativity, no object with mass can be accelerated to the speed of light. To get even close to the speed of light requires enormous amounts of energy. “For example, to accelerate a bowling ball to the speed newly measured in these blazars would require all the energy produced in the world for an entire week,” Piner said, “and the blobs of plasma in these jets are at least as massive as a large planet.”



Very Long Baseline Array (VLBA) sequence of blazar 0827+243. This sequence shows plasma moving away from the blazar's core. The core is the bright red dot at right; the plasma is the blue object to the left. The VLBA images show the plasma's motion over about 8.4 months. Credit: Piner et al., NRAO/AUI/NSF

► **Bringing the House Down.** Using two of the largest indoor shake tables in the world, researchers at the University at Buffalo, SUNY, subjected a full-size, wood-frame townhouse to the shaking of the 1994 Northridge, Calif., earthquake. The simulation was the first to subject a full-scale, finished home to the reproduced forces of an earthquake.

The two-story, three-bedroom townhouse was completely furnished and equipped, complete with a car in the attached garage, two water heaters—one anchored, according to earthquake protection measures, and one not—and dishes on the dining room table. For the first time, researchers observed a rocking motion during the largest shaking, a phenomenon that appeared to reduce the seismic forces and prevented the house’s collapse.

Full-size, two-story townhouse astride the NEES dual shake tables at the University at Buffalo, SUNY. *Credit: Credit: John W. van de Lindt and the project web site* [*http://www.engr.colostate.edu/NEESWood*](http://www.engr.colostate.edu/NEESWood)

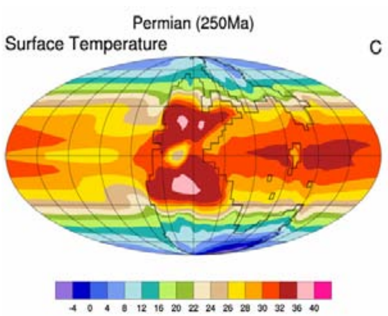
More than 80 percent of U.S. housing is wood frame construction. The results provide new insights for improving design and construction of wood frame structures, eventually enabling the construction of larger, taller wood structures in seismic regions.

The Buffalo facility is just one component of NSF’s multi-institution George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES). The Nov. 2006 test was part of a larger collaboration involving researchers in the United States and Japan. In 2009, a six-story wood frame structure pre-fabricated in the United States will be shipped to Miki City, Japan to be tested on the world’s largest shake table..

The Central Yoke of the CMS Detector. *Credit: CERN*

► **CMS Turns On**: On July 26, 2006, scientists announced that the giant Compact Muon Solenoid (CMS) detector at CERN, the European Organization for Nuclear Research, in Geneva, Switzerland, had been sealed and switched on to collect data for an important series of tests using cosmic ray particles.

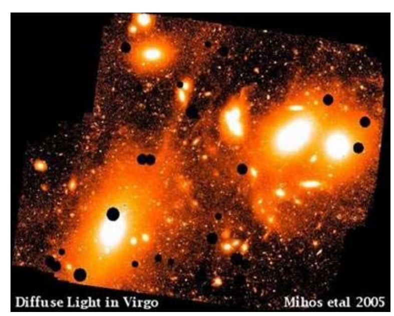
The test data is being used to calibrate and align the CMS, which is receiving joint U.S. funding from the Department of Energy (DOE) and NSF. Next year, when CERN's Large Hadron Collider (LHC) is scheduled to begin operations as the world's largest particle accelerator, CMS will be one of four major detectors used to observe the products of collisions of high energy protons at the LHC. The detector will thus help answer questions such as what gives matter its mass, what composes the invisible 96 percent of the universe, why nature prefers matter to antimatter and how matter evolved from the first instants of the universe’s existence. U.S. scientists collaborate on all four experiments.



► **Climate Models Give Clue to Greatest Mass Extinction in Earth's History:** Scientists at the National Center for Atmospheric Research have used a computer model to simulate the Earth's climate at the time of the Permian Extinction, when 90 to 95 percent of all marine species and 70 percent of terrestrial species became extinct. The researchers used the Community Climate System Model (CCSM), which integrates changes in atmospheric temperatures with ocean temperatures and currents. The work supports the theory that an abrupt and dramatic rise in atmospheric carbon dioxide triggered the extinction 251 million years ago.

This large pulse of carbon dioxide seems to have come from an equally large burst of volcanic activity that played out over the relatively short span of some 700,000 years. According to the model, the resulting rise in carbon dioxide levels raised the temperature of the atmosphere, which in turn raised the temperature of the oceans’ surface waters. Once this warming of the oceans reached a depth of 4,000 meters, it interfered with the seas’ normal circulation process and kept oxygen from moving into the deep ocean. This lack of oxygen then killed the marine organisms that normally would have removed carbon dioxide from the atmosphere. The result: an even faster rise in carbon dioxide levels, thereby increasing the temperatures on land and in the ocean even further.

► **A Vast Stellar Web Spun by Colliding Galaxies:** Case Western Reserve University astronomers have captured the deepest, wide-field image ever obtained of the nearby Virgo cluster of galaxies. The image reveals for the first time that the space between the cluster galaxies is filled with a vast, complex web of “intracluster starlight” nearly 1,000 times fainter than the dark night sky. The streamers, plumes and cocoons that make up this extremely faint starlight are made of stars ripped out of galaxies as they collide with one another inside the cluster, and act as an “archaeological record” of their violent lives. The Virgo image was captured through Case's newly refurbished 24-inch Burrell Schmidt telescope, located at the Kitt Peak National Observatory in Arizona.



The deep, wide-field image of the Virgo Cluster, revealing its complex web of diffuse intracluster light. *Credit: Chris Mihos, Paul Harding, John Feldmeier, Heather Morrison (Case Western Reserve University)*

NSF-WIDE INVESTMENTS

NATIONAL SCIENCE FOUNDATION CENTERS

NSF supports a variety of centers programs that contribute to the Foundation's mission and vision. 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, duration, equipment, facilities, and students. Centers are the principal means by which NSF fosters interdisciplinary research.

NSF Centers Funding

(Dollars in Millions)

	Program Initiation	FY 2006 Number of Centers	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
Centers for Analysis & Synthesis	1995	2	$6.40	$6.46	$11.46	$5.00	77.4%
Chemical Bonding Centers	1998	6	1.50	3.00	9.00	6.00	200.0%
Earthquake Engineering Research Centers	1988	3	6.00	-	-	-	N/A
Engineering Research Centers	1985	19	60.18	62.79	52.86	-9.93	-15.8%
Materials Research Science & Engineering Centers	1994	29	53.50	55.70	59.20	3.50	6.3%
Nanoscale Science & Engineering Centers	2001	16	40.04	37.35	42.35	5.00	13.4%
Science & Technology Centers	1987	17	62.58	67.48	66.20	-1.28	-1.9%
Science of Learning Centers	2003	6	20.66	27.00	27.00	-	-
		98	$250.86	$259.78	$268.07	$8.29	3.2%

Totals may not add due to rounding.

CENTERS DESCRIPTIONS

Centers for Analysis and Synthesis (BIO)

The Centers for Analysis and Synthesis are designed to continue development of new tools and 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, and begin to host and curate databases. The centers have a critical role in organizing and synthesizing biological knowledge that is useful to researchers, policy makers, government agencies, educators, and society.

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 National Evolutionary Synthesis Center (NESCent) is a collaborative effort by Duke University, North Carolina State University, and the University of North Carolina at Chapel Hill to foster a greater conceptual synthesis in biological evolution by bringing together researchers and educators, extant data, and information technology resources.

A Plant Science Cyberinfrastructure Collaborative will be established in FY 2008 to create intellectual synergy among biologists, computer and information scientists, mathematicians, engineers, and others to drive discovery and enable new conceptual advances through integrative, computational approaches.

Chemical Bonding 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." Selected 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.

The CBC program is being built year-by-year, with an incremental approach to support for outstanding proposals. Phase I awards support preliminary proposals. Phase II awards fund full-scale center implementation. In FY 2008, phase I awardees from FY 2005 are expected to compete for phase II funding. In addition, a new phase I competition is being held in FY 2007.

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 concluded as planned in FY 2006.

Engineering Research Centers (ENG)
NSF's Engineering Research Centers (ERCs) are proven cauldrons of innovation, bridging the energy and intellectual curiosity of universities with the real-world applications of industry-focused research. These centers also are uniquely successful in educating a technology-enabled workforce with hands-on, real-world experience. These characteristics create an environment that catalyzes the development of marketable technologies to generate wealth and address engineering grand challenges, many of which intersect with the Administration's American Competitiveness Initiative. This is particularly evident in ERCs that address hydrogen as an alternative fuel, biomedical healthcare innovations, and multimedia information systems.

ERCs succeed in these areas because they provide the intellectual foundation for industry collaboration with faculty and students to resolve long-range challenges, continue the 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, 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 Research Science and Engineering Centers (MPS)
Materials Research Science and Engineering Centers (MRSECs) support interdisciplinary materials research addressing fundamental problems of intellectual and strategic importance that are critical for American competitiveness and the development of future technologies. The MRSECs also support shared experimental facilities, place strong emphasis on the integration of research and education at all levels, and provide seed 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, enabling the development of marketable technologies that depend on new classes of materials and the discovery, control, and innovative exploitation of materials phenomena. Areas of potential technological impact include computers and communications, transportation, energy storage, structural engineering, health, and medicine. MRSECs also foster research and educational partnerships among academic institutions in the U.S. as well as international partnerships.

Open competitions for NSF support are held triennially. The 2005 MRSEC competition yielded two new centers devoted to biotechnology and interfaces in semiconductor materials, respectively. The phase out that began in FY 2006 of three centers will be completed in FY 2007.

Nanoscale Science and Engineering Centers (multi-directorate)
Nanotechnology, which addresses technology on the smallest of scales, is projected to be one of the largest drivers of technological innovation for at least the next decade and beyond. This potential was recognized in the National Nanotechnology Initiative and more recently in the American Competitiveness Initiative, particularly in the burgeoning area of nanomanufacturing. Research at the nanoscale through NSF-funded Nanoscale Science and Engineering Centers 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 further public understanding of nanoscale science and engineering. The centers have strong partnerships with industry, national laboratories, and international centers of excellence, which puts in place the necessary elements to bring discoveries in the laboratory to real-world, marketable innovations and technologies. There are 16 NSECs, including one Network on Nanotechnology in Society. Four NSECs on nanomanufacturing will establish the National Nanomanufacturing Network in FY 2007.

Science and Technology Centers (multi-directorate)
The Science and Technology Centers (STCs) program advances discovery and innovation in science and engineering through the integration of cutting-edge research, excellence in education, targeted knowledge transfer, and the development of a diverse workforce while broadly advancing the goals and objectives of the American Competitiveness Initiative (ACI). The STC research portfolio is very broad. Examples of continuing investment include areas of cyber-security, advanced sensors and embedded networked sensing, revolutionary materials for information technology, advanced nano/microfabrication capabilities, new materials and technologies for monitoring water resources and water quality, medical devices, and, modeling and simulation of complex earth environments for improving their sustainability and weather/climate prediction. STCs engage the Nation's intellectual talent, robustly drawn from its full human diversity through partnerships between academia, industry, national laboratories, and government. These partnerships ensure timely transfer of knowledge and technology from the laboratory to appropriate industries, the application of patents derived from the work of the STCs, the launching of spin-off companies, and creation of job opportunities. In addition, STCs have impressive records of research training of undergraduate students, graduate students, postdoctoral fellows, established researchers, and educators as well as contributions to K-12 education, industry, and other sectors.

Science of Learning Centers (multi-directorate)
In FY 2008, NSF will support the fourth of five initial years of funding for three Centers awarded in the program's first competition, and will continue supporting three centers initiated in FY 2006 after a second competition. The young portfolio of SLCs represents synergistic, exciting research efforts that address important questions central to our understanding of learning and its societal implications. Topics include: Influence of interplay between informal and formal environments on learning processes; combination of modeling and experimental studies of brain and behavior toward understanding of real-time autonomous learning; use of learning technologies to study robust learning in classrooms; the processes involved in learning visual languages, and their applications for language processing; the influence of timing and temporal dynamics on learning; and processes underlying spatial intelligence and learning.

Continuing in FY 2008, NSF will focus on the growth and development of individual centers (and potential merit-based renewal of the first cohort of centers) and the development of infrastructure and support to coordinate activities among SLCs and other NSF centers. These will include capacity building for research communities involved in science of learning through new partnerships and collaborations that benefit, and can benefit, from SLCs. Such opportunities, open to researchers both in- and outside centers (including international partnerships), augment program strategies aimed at engaging outside researchers in SLC efforts and more fully leverage investments already made in SLCs as national resources available to other researchers. In addition, activities at the SLCs stimulate and involve participation of underrepresented minorities in research at the frontiers of science, and facilitate knowledge transfer and dissemination to the research communities, industry, and the general public.

FY 2006 Estimates for Centers Participation
(Dollars in Millions)

	Number of Participating Institutions	Number of Partners	Total FY 2006 NSF Support	Total Leveraged Support	Number of Participants
Centers for Analysis & Synthesis	4	20	$6	$2	736
Chemical Bonding Centers	60	13	$2	$3	358
Earthquake Engineering Research Centers	49	74	$6	$13	1,004
Engineering Research Centers	228	425	$60	$89	10,803
Materials Research Science & Engineering Centers	108	335	$54	$44	5,323
Nanoscale Science & Engineering Centers	137	274	$40	$17	7,170
Science & Technology Centers	173	313	$63	$33	2,522
Science of Learning Centers	20	11	$21	$8	366

No. of Participating Institutions: all acadmeic institutions that participate in activities at the centers.

No. of Partners: the total nubmer of non-academic participants, including industry, states, and other fed agencies at the centers.

Total Leveraged Support: funding for centers from sources other than NSF.

No. of Participants: the total number of people who use center facilities, not just persons directly support by NSF.

Centers Supported by NSF in FY 2006

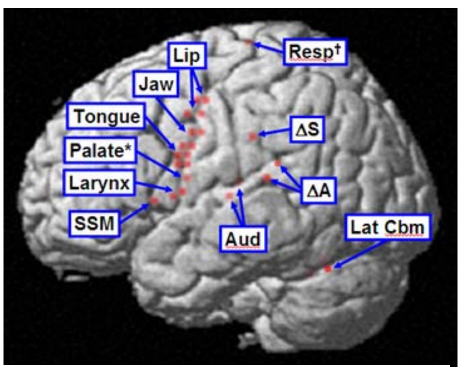
Center	Institution	State
Centers for Analysis and Synthesis		
National Center for Ecological Analysis and Synthesis (NCEAS)	U of California-Santa Barbara	CA
National Evolutionary Synthesis Center (NESCent)	Duke, NC State, U of N. Carolina	NC
Chemical Bonding Centers		
Activation and Transformation of Strong Bonds	U of Washington	WA
Center for Molecular Cybernetics	Columbia	NY
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
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 Technology	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
Collaborative Adaptive Sensing of the Atmosphere	U of Mass-Amherst	MA
Compact and Efficient Fluid Power	U of Minnesota	MN
Computer-Integrated Surgical Systems and Technologies	Johns Hopkins	MD
Engineered Biomaterials	U of Washington	WA
Engineering of Living Tissue	Georgia Institute of Technology	GA
Environmentally Beneficial Catalysis	U of Kansas	KS
Extreme Ultraviolet Science and Technology	Colorado State	CO
Integrated Media Systems	U of Southern California	CA
Mid-IR Tech for Health and the Environment	Princeton	NJ
Power Electronic Systems	Virginia Tech	VA
Quality of Life Technology	Carnegie Mellon/U of Pittsburg	PA
Reconfigurable Machining Systems	U of Michigan	MI
Structured Organic Composites	Rutgers	NJ
Subsurface Sensing and Imaging Systems	Northeastern	MA
Synthetic Biology	U of California-Berkeley	VA
Wireless Integrated MicroSystems	U of Michigan	MI
Materials Research Science and Engineering 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 Technology	MA
Center for Micro- and Nanomechanics of Materials	Brown	RI
Center for Multifunctional Nanoscale Materials Structures	Northwestern	IL
Center for Nanomagnetic Structures	U of Nebraska	NE
Center for Nanoscale Science	Pennsylvania State	PA
Center for Nanoscopic Materials Design	U of Virginia	VA
Center for Nanostructured Interfaces	U of Wisconsin	WI
Center for Nanostructured Materials	Columbia	NY
Center for Polymer Science and Engineering	U of Massachusetts	MA
Center for Polymer Interfaces and Macromolecular Assemblies	Stanford, UC-Davis, IBM	CA

Center for Polymers at Engineered Interfaces	SUNY-Stony Brook, CUNY, Polytech	NY
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
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	Johns Hopkins	MD
Nanoscale Science and Engineering Centers		
Affordable Nanoengineering of Polymer Biomedical Devices	Ohio State	OH
Center for Integrated and Scalable Nanomanufacturing	U of California-Los Angeles	CA
Directed Assembly of Nanostructures	Rensselaer Polytechnic Institute	NY
Electronic Transport in Molecular Nanostructures	Columbia	NY
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 California-Merced	CA
Integrated Nanopatterning and Detection Technologies	Northwestern	IL
Molecular Function at the Nano/Bio Interface	U of Pennsylvania	PA
Nanoscale Systems in Information Technologies	Cornell	NY
Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems	U of Illinois-Champaign-Urbana	IL
Nanoscience in Biological and Environmental Engineering	Rice	TX
Probing the Nanoscale	Stanford, IBM	CA
Science of Nanoscale Systems and their Device Applications	Harvard	MA
Templated Synthesis and Assembly at the Nanoscale	U of Wisconsin-Madison	WI
Nanotechnology in Society Network	Ariz St, U of California-Berkeley, U of Southern Calif, Harvard	AZ, CA, MA
Network for Hierarchical Nanomanufacturing	U of Massachusetts-Amherst	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
Coastal Margin Observation and Prediction	Oregon Health and Science U	OR
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
Layered Polymeric Systems	Case Western Reserve U	OH
Materials and Devices for Information Technology Research	U of Washington	WA
Microbial Oceanography: Research and Education	U of Hawaii	HI
Multi-Scale Modeling of Atmospheric Processes	Colorado State U	CO
Nanobiotechnology	Cornell	NY
Remote Sensing of Ice Sheets	U of Kansas	KS

Sustainability of Semi-Arid Hydrology and Riparian Areas	U of Arizona	AZ
Ubiquitous Secure Technology	U of California-Berkeley	CA
Science of Learning Centers		
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
VL2: Visual Language and Visual Learning	Gallaudet	DC
SILC: Spatial Intelligence and Learning Center	Temple	PA
The Temporal Dynamics of Learning	U of California-San Diego	CA

Recent Research Highlights

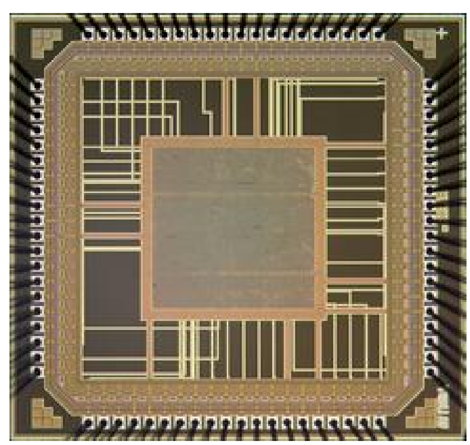
► **Babbling Computer May Help Teach Kids To Speak:** Scientists at the Center of Excellence for Learning in Education, Science, and Technology, an NSF-funded Science of Learning Center hosted by Boston University, are developing a computer model of speech production. The model identifies computations performed by the brain to produce tongue movements that make speech sounds. Like an infant, the model uses a babbling phase to learn how to speak. After babbling, the model learns to produce new speech sounds it “hears” from a human speaker, much as an infant learns to produce new words by imitating parents. The components of the model correspond to precisely defined regions of the brain. By illuminating the neural computations responsible for speech, as well as the ways in they malfunction, the model can help guide the design of therapies for individuals with speech disorders such as stuttering. The model's focus on speech learning also provides insights into the best ways to teach speech to children and learners of a second language. (SBE/SLC).



The locations of the model's components on the left hemisphere of the cerebral cortex and cerebellum. *Credit: Frank Guenther, Boston University.*

► **A Powerful Platform for Implantable Prosthetic Devices:** Work by researchers at the Engineering Research Center for Biomimetic MicroElectronic systems may enable a broad range of implantable prosthetic devices. The center, headquartered at the University of Southern California, is developing new platforms for devices that restore vision, revive paralyzed limbs, and overcome some kinds of cognitive impairments. The new implantable devices would integrate seamlessly with the human body – replacing missing or damaged neuronal function. The enabling technologies range from wireless power and data systems to hermetically sealed packaging and low-power, bio-based, integrated circuits.

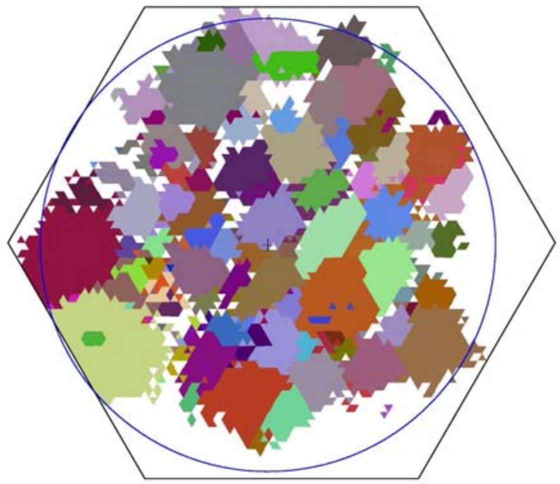
The center has developed a state-of-the art, mixed-signal, very large scale integration (VLSI) chip. The chip has more than 100,000 transistors and combines both digital and analog circuits to mimic biological function. The highly flexible platform is ideal for new implantable prosthetic devices that could revolutionize treatment for many serious disabilities. (ENG/ERC).



A novel mixed-signal system on a chip, which is a platform for implantable prosthetic devices. *Credit: Center for Biomimetic MicroElectronic Systems.*

► **X-Ray Vision for Materials:** Researchers at Carnegie Mellon University, together with scientists at the Advanced Photon Source, have developed a non-destructive method to visualize the arrangement and orientation of individual crystals within a solid material. High energy X-rays from a synchrotron light source penetrate the material and interact with the crystals in their path. The pattern of transmitted X-rays that emerges from the material is then analyzed by custom software to determine the internal structure of the material.

Because the complete X-ray/crystal interaction is modeled, this technique yields far more data than is contained in conventional radiograms. This new tool allows scientists to see within opaque materials with unprecedented detail and, therefore, allows the visualization of a wide range of previously hidden processes, such as crack formation in structural materials. (MPS/MRSEC).

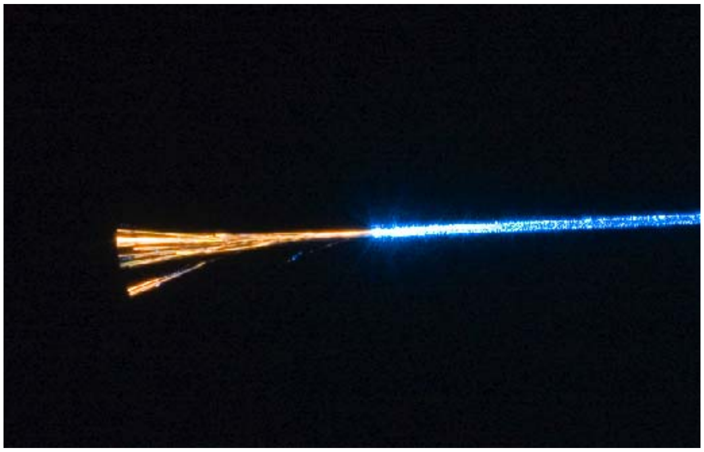


A two-dimensional slice of the microstructure inside of an aluminum wire, 1 mm in diameter (the blue circle). Each color corresponds to a different crystal orientation. *Credit: R.M. Suter, MRSEC, Carnegie Mellon University.*

► **New Process Builds Electronics Into Optical Fiber:** Scientists from Pennsylvania State University and the University of Southampton in the United Kingdom have demonstrated a new way to combine microelectronics and optical fibers – a development that opens up potential applications in fields as diverse as medicine, computing, and remote sensing.

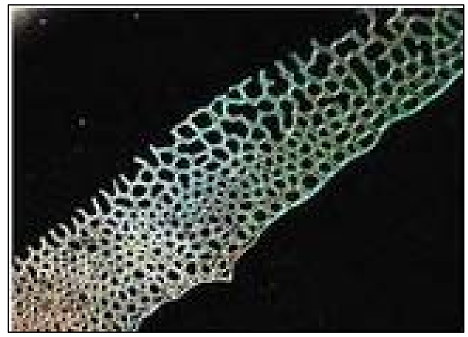
The researchers have discovered how to fashion a thin, flexible tube of ultra-clear glass – an optical fiber – that has a hollow core packed with microscopic wires made of a semiconductor such as germanium. The scientists then created solid-state electronic devices, including a transistor, inside the semiconductors.

"This advance is the basis for a technology that could build a large range of devices inside an optical fiber," says Penn State chemist John Badding, one of the lead authors of the report. (MPS/MRSEC).



A wire-packed glass fiber. Each of the semiconductor wires is just two micrometers in diameter – 1/20th the width of a human hair. *Credit: Neil Baril, Penn State University.*

► **VISUAL: Bridging Art and Science:** When a drop of coffee dries it leaves a ring, which contains material that was dissolved in the water. The same thing happens with a polymer that is dissolved in a solvent. Shown here is an optical microscope image of a "ring" of the dried-out polymer. The colors and shapes provide clues that help scientists understand and control the drying process. Beautiful images like this are at the core of VISUAL (*Ventures In Science Using Art Laboratory*) which is serving as a catalyst to convey science through art to the public and K-12 students. Through the University of Massachusetts Materials Research Science and Engineering Center and Vice-Provost's office, VISUAL sponsored two symposia focusing on the bridge between art and science, which serves as the centerpiece for two simultaneous art exhibitions at the Fine Arts Center on the Amherst campus and a new course on science in the arts, designed specifically for this event. With VISUAL in the lead, a reintegration of art and science is beginning that will serve as a unique educational venue for the public and students of all ages. (MPS/MRSEC).



Not a snakeskin, but a magnified image of a dried polymer "ring" taken with an optical microscope. *Credit: University of Massachusetts-Amherst.*

► **Rapidly Deployable Robotic Aquatic Observing System:** A group of NSF-supported researchers have developed a technology for rapidly deploying a sensor system to monitor small water bodies such as lakes and streams. They have recently demonstrated this technology to study the formation and growth of cyanobacterial scum in a shallow lake in Southern California over a series of week-long deployments.

The technology has three physical constituents connected using a wireless network. A collection of buoys are deployed to continually monitor temperature and chlorophyll at fixed locations. A robotic shuttle supported on a cable strung across the lake is used to produce dense scans of water parameters in a vertical transect. A robotic boat is used to 'fill in' the sensing gaps across the water surface. The system functions in coordination because the statistical sampling algorithms that control the movement of the boat and the shuttle use data collected by the buoys to predict the most advantageous motion patterns for the mobile entities. (CISE/STC).

Robotic Aquatic Observing System. *Credit: Center for Embedded Networked Sensing (CENS).*

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 (www.climatescience.gov) as a follow-on to the acclaimed US Global Change Research Program (USGCRP). 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 fundamental discovery, utilizing the full range of intellectual resources of the scientific community; research infrastructure, to provide advanced capabilities; and innovative educational activities. 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 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
Biological Sciences	$15.10	$15.10	$15.10	-	-
Engineering	1.00	1.00	1.00	-	-
Geosciences	149.35	157.72	160.72	3.00	1.9%
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	$196.88	$205.25	$208.25	$3.00	1.5%

Totals may not add due to rounding.

FY 2008 Areas of Emphasis:

Atmospheric Composition – NSF programs in tropospheric and stratospheric chemistry will continue in FY 2008 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 transport and transformation of gaseous constituents and aerosols provide insights into the radiative and cloud nucleating properties of the atmosphere. Greenhouse gases are particularly important since they are the principal absorbers and re-radiators of heat. Results of these studies serve as important inputs for the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

Climate Variability and Change – As a major focus in FY 2008, NSF programs will 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. Work continues to add additional complexity to the models so that they will better incorporate 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 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 utilize more effectively 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. Highly resolving models with cloud system processes models are being refined to address the persistent problem of moist convection and cloud processes – two of the more challenging and uncertain components in climate change calculations. Several prototype hydrologic observatories are being established through Science and Technology Centers that work with stakeholders responsible for water management who translate research advances into useful products, particularly on issues related to decision-making in the face of uncertainty as applied , for example, 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.

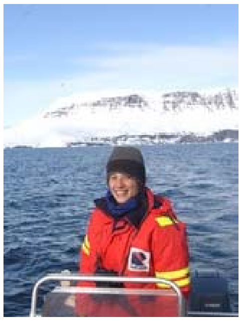
Global Carbon Cycle – FY 2008 funding supports a wide variety of carbon cycle research activities. Investigations will examine a range of topics in terrestrial and marine ecosystems and their relations to the carbon cycle. Research in terrestrial settings will explore, for example, carbon storage, delivery of carbon by rivers, carbon fluxes from high-latitude soils, carbon export from mountains, and submarine groundwater discharge. In the oceans, biotic and abiotic carbon cycling, and the upper ocean carbon budget are important issues to 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. Research will continue to focus on understanding the impact of increasing carbon dioxide levels on the calcification rates, productivity and symbiotic relationships of hermatypic (reef-building) 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 2008 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.

Recent Research Highlights

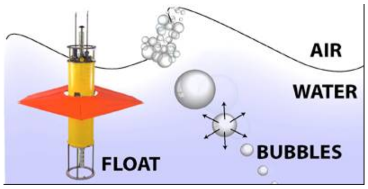
► **Arctic Cetaceans – Indicators of Climate Change:** The Arctic is currently experiencing dramatic changes in sea ice characteristics and marine productivity. The behavioral patterns, life history and ultimate existence of arctic cetaceans – mammals most fully adapted to aquatic life – are tightly linked with changes in the arctic environment. For this reason, they are both vulnerable to climate alterations, and are good indicators of cumulative changes.



Dr. Kristin Laidre in May 2005 in West Greenland during field work under the International Research Fellowship Program. *Credit: Kristin Laidre.*

Kristin Laidre, an early career researcher at the Greenland Institute of Natural Resources, investigated the vulnerability of arctic cetaceans to climate change by examining three species of cetaceans: the narwhal, beluga, and bowhead whales. The whales, which inhabit the arctic waters of West Greenland, are ideal for monitoring biophysical changes impacted by a warming climate.

Laidre measured the trends in sea ice and primary production using satellite telemetry data (the use of transmitters to track wildlife) on whale movements and diving behavior and remotely-sensed environmental data. Her work has facilitated the understanding of the potential effects of climate change on arctic marine mammals and led to the development of an index that ranks the mammals' vulnerability to these changes. (OISE).



Bubbles created by breaking surface waves, carried downward by currents and dissolving at about 10m depth supersaturated the ocean in oxygen and nitrogen. *Credit: Eric D'Asaro, UW/APL.*

► **Enhanced Gas Exchange between the Ocean and Atmosphere under Hurricanes:** Hurricanes and climate may form a vicious circle, some scientists have speculated. Even as global warming produces more hurricanes, they argue, the increasingly frequent hurricanes are churning up the surface of the ocean and releasing dissolved carbon dioxide back into the atmosphere, which enhances the warming.

Now, however, a team of NSF-funded researchers at the University of Washington and the University of Rhode Island have finally been able to test this hypothesis. They have developed a new generation of instrument-bearing floats that can reliably monitor the flux of carbon dioxide from the ocean surface, even in the midst of hurricane-force winds. They have made the first measurements of that flux during major storms, starting with Hurricane Frances in 2004. And they have found that, from a global perspective, hurricanes are *not* important in releasing dissolved carbon dioxide.

The new, air-deployable floats could also help scientists study many other aspects of the ocean in remote locations and in severe weather conditions, including the role of dissolved oxygen and nitrogen in the biological productivity of the ocean. (GEO).

CYBER-ENABLED DISCOVERY AND INNOVATION (CDI)

Objective: *Broaden the Nation's capability for innovation by developing a new generation of computationally based discovery concepts and tools to deal with complex, data-rich, and interacting systems.*

Fundamental research has created the foundation of concepts, techniques, and tools on which today's digital age is based. The Nation's preeminence in information technology is widely recognized as an essential element in our competitiveness, both as a leading technology and in the way it has enabled innovation across many fields, starting with science and engineering and permeating all aspects of society.

Conduct of science and engineering has been revolutionized by the infusion of computational science and simulation in the traditional experimentation-observation-analysis-theory loop and by eliminating the geographic constraints for collaboration and experimentation. Ongoing investments by NSF and others have demonstrated the power of these approaches and led to our major investments in cyberinfrastructure that enable their application. Many important challenges are being tackled with these techniques and it is clear that this needs to be accelerated.

At the same time, looking beyond today's cyberinfrastructure, it is clear that new concepts and tools are needed to address the challenges posed by a world of petascale computers, massive data flows and databases, and an economy dependent on digitally enabled activity. Future competitiveness will clearly be dependent on scientific leadership and education that goes well beyond today's applications of the earlier concepts underlying the digital age.

CDI is a research initiative that will stimulate new capabilities to deal with these and similar challenges, including directly addressing NSF's "Cyberinfrastructure Vision for the 21st Century." The insights from this activity can be translated to other non-research systems and will be an essential contribution to the Nation's renewed focus on competitiveness.

Description

Scientists and engineers are faced with research problems that often have many complex internal feedback processes that defy simple analysis, or that must be studied at scales that are much different than processes occurring in nature. Some research problems require extensive complex networked observations. These challenges often need massive datasets for simulation, have heterogeneous data sources that must be linked, or generate massive, high-dimensional datasets from experiment or observation, and will soon be beyond today's capabilities.

This initiative aims to explore radically new concepts, approaches and tools at the intersection of computational and physical or biological worlds to address such challenges. It includes five distinct themes - knowledge extraction, interacting elements, computational experimentation, virtual environments, and education for computational discovery. New means of computational discovery will augment the traditional discovery-innovation loop with novel computational concepts to aid knowledge discovery, analysis and experimentation. This will accelerate the discovery of knowledge buried in massive datasets, creation of models to understand complex phenomenon, and understanding of rare events.

Areas of Emphasis

Knowledge extraction. Finding genomic expressions of cereal DNA, discovering new, fundamental particles predicted by the standard model, and finding new planets and proto-stars – all are like 'finding a needle in a haystack.' Knowledge extraction encompasses a variety of techniques – data mining, visualization, utilization of basic concepts from computation, geometry and topology – to help scientists and engineers find what is most important in the almost infinite amounts of data from sensors, telescopes, satellites, the media, the Internet, surveys, etc. Combining underlying conceptual ideas with heterogeneous data from multiple sources, high-bandwidth communications, and tera- to petascale computational power, scientists and engineers will be able to make sense of the massive volumes of data that bear on their grand challenges and address one of the most daunting challenges of the present century. This theme will improve across current techniques, which are insufficient for these challenges.

Complex interactions. Analyzing the flow of electricity or information across the electric power grid or the Internet, describing protein folding and unfolding, and finding superposition principles for scaling from the quantum- to the nano- to the macro-scales are examples of grand challenges that require scientists and engineers to understand interacting systems. Such systems, ranging from particles to galaxies and from computer networks to societies, are at the heart of many science and engineering grand challenges, and their understanding and control are major sources of innovation. Key factors in such systems are the large number of interacting elements, non-linearity of interactions, and aggregate or emergent phenomena observed at certain scales. This theme will improve both forward (predictive) and inverse (deductive) capabilities in order to better understand nature, and be able to design, control and make decisions about complex systems.

Computational experimentation. We cannot generate a hurricane to see how it develops and progresses; use routine brain surgery to experiment on neural synapses in the brain; or rerun the "Big Bang" to see how the physics of the universe develops. Computational experimentation allows insight into complex systems by enabling the creation of a virtual description (algorithmic or computational) that can interact with elements from the real world. Simulation and other dynamic modeling techniques allow us to experiment with complex systems in ways that would be unimaginable in the real world, and to constrain our understanding of the system characteristics or underlying physical phenomena. Furthermore, it allows us to guide real world operations and experimentation in cases that have potential for unforeseen or extreme events. Research in this area will provide needed new modeling techniques ranging from mathematical formulations to multi-scale simulation techniques.

Virtual environments. Scheduling and operation of distributed facilities and sensor arrays, data extraction and analysis, international real time comparative analyses of global climate models, and injecting discovery and innovative environments in STEM learning and training - all require the use of virtual environments as important mechanisms to enhance discovery, learning, and innovation. Virtual environments enabled by cyberinfrastructure permit collaboration among diverse populations spread across geographic distances and time zones. This theme will develop new techniques for building and utilizing virtual environments, especially in the context of cyberinfrastructure.

Educating researchers and students in computational discovery is essential. Without explicit attention to this, the promise of new capability, as well as the translation of these capabilities into other segments of the economy, will not be realized. We will emphasize integrating computational discovery techniques into the basic education of all scientists and engineers as well as development of new techniques for use in all areas, not just science and engineering. Research on the role and impact of computational discovery in education, educational practice and learning in general is also important.

Special focus will be placed on the utilization of virtual environments and cyberinfrastructure in education at all levels. By enhancing human cognition/perception in dealing with complexity, computational tools provide an essential handle on workforce development for the 21st century.

Several NSF directorates and the Office of Cyberinfrastructure will participate in developing advanced applications of the new concepts and tools flowing from the basic objectives of this investment. It is fundamental work clearly appropriate for NSF. Work will be coordinated with other agencies via the NITRD Subcommittee and other relevant subparts of National Science and Technology Council. It is critical over the next five years to leverage on-going investments, such as cyberinfrastructure, and to prepare for the coming computational discovery challenges in all fields.

Funding

A five-year initiative with a first-year total of $51.98 million is needed, growing to at least $150.0 million by the third year. Growth of about $50.0 million per year for a full 5 years is suggested.

Long-term Funding for Cyber-enabled Discovery and Innovation

(Dollars in Millions)

FY 2008 Request	FY 2009	FY 2010	FY 2011	FY 2012
$51.98	$100.00	$150.00	$200.00	$250.00

It is clear that new concepts and tools are needed to address research at the frontier. With CDI, at the end of five years, we expect to have: **enhanced ability** to deal with research requiring petascale cyberinfrastructure, a strengthened **technical basis** for a new generation of computational discovery in all areas of S&E, and **significant progress** in educating computational discoverers.

CYBERINFRASTRUCTURE

Science and engineering have undergone a revolution in which the traditional approach of observation, experimentation, theory, and analysis has been dramatically enhanced by use of advanced computing and communication technology with information in digital form. Digital interfaces found in modern laboratory equipment can be networked to make it possible for scientists to directly participate in experiments from across the country or around the globe. Wired, wireless, and optical networking and the growth of autonomous systems enable researchers to deploy elaborate webs of sensors in domains as diverse as environmental science and astronomy. Advances in the analysis and visualization of digital data permit researchers to analyze large, complex collections of data. Information technology has made it possible for groups of collaborating researchers to overcome distance and work together more effectively as they tackle the hard problems of modern science and engineering.

In parallel with the emergence of digital technologies that increase the capabilities of researchers, the questions at the forefront of scientific and engineering research have become increasingly complex. Researchers wish to unravel the way multiple processes, interacting over multiple space and time scales, produce the rich variety of phenomena seen in complex systems. Such complex systems permeate the natural and engineered world, from the intricate workings of a cell to the emergence of structure in the early universe and the workings of the internet. Advances in understanding in the digital realm are providing the tools that help researchers tackle the new research challenges in the physical, biological, and social sciences.

The term ***cyberinfrastructure*** was coined to encompass many of the systems used for working with digital information that have the potential to fuel advances in research, education, industry, and society. NSF has supported pioneering efforts by researchers to develop components of cyberinfrastructure, to use these components to break new ground in science and engineering research, and to investigate how cyberinfrastructure should be integrated into the research and education enterprise. The success of these and related programs has demonstrated the power of cyberinfrastructure and caused many research communities to express an urgent need both for greater access to and for new types of cyberinfrastructure.

Cyberinfrastructure Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Percent
Biological Sciences	$84.00	$90.50	$95.50	$5.00	5.5%
Computer and Information Science and Engineering	64.37	68.00	87.00	19.00	27.9%
Engineering	52.00	54.00	58.00	4.00	7.4%
Geosciences	71.35	75.00	75.00	-	-
Mathematical and Physical Sciences	58.64	63.56	64.56	1.00	1.6%
Social, Behavioral and Economic Sciences	20.54	20.54	20.54	-	-
Office of Cyberinfrastructure	127.14	182.42	200.00	17.58	9.6%
Office of International Science and Engineering	1.00	1.05	0.75	-0.30	-28.6%
Office of Polar Programs	26.24	26.24	26.24	-	-
Subtotal, Research and Related Activities	505.28	581.31	627.59	46.28	8.0%
Education and Human Resources	15.22	16.00	16.50	0.50	3.1%
Total, Cyberinfrastructure Funding	$520.50	$597.31	$644.09	$46.78	7.8%

Totals may not add due to rounding.

Input from the research and education communities led NSF to develop the document, *A Cyberinfrastructure Vision for the 21st Century,* which defines NSF's leadership roles in an integrated system of high performance computation services, services for managing massive and heterogeneous data/information, sensing and observation across multiple scales of time and space, multimode visualization and interaction, and distributed team collaboration. It also describes learning and workforce issues associated with applying cyberinfrastructure to learning as well as the learning required to use cyberinfrastructure. Achieving the vision requires linking three complementary activities: 1) research and development of tools, concepts, and technologies; 2) provisioning of leading-edge cyberinfrastructure systems; and 3) the application of cyberinfrastructure to advance our understanding of the world around us, respond to emergencies, and provide more authentic and motivational STEM learning opportunities for students, teachers, professionals, and the general public. Investments in FY 2008 are designed to capitalize on the results of the pioneering early forays into cyberinfrastructure and to advance research and education through the implementation of the strategies laid out in this vision.

Grand challenges in many fundamental research areas, from climate modeling, to design and production of materials with specialized properties at the atomic level, to simulation of black hole collisions and gravity wave sources, to exploring water systems, to the dynamics of monetary flows across national boundaries, will benefit from investments in cyberinfrastructure. 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 origin of life, revolutionizing our understanding of the major kingdoms of life, and 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.

The American Competitiveness Initiative (ACI) describes the goal of providing world-leading high-end computing capability, coupled with advanced networking, to enable scientific advancement through modeling and simulation at unprecedented scale and complexity across a broad range of scientific disciplines. NSF investments in high-performance computing for research and education, the TeraGrid infrastructure, middleware investments, and international network connections directly contribute to the goals of the ACI. The enormous growth in the availability and utility of cyberinfrastructure capabilities, both technology- and human-based, is increasing the productivity of scholarly research, 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.

All NSF activities participate in support for cyberinfrastructure. The Office of Cyberinfrastructure (OCI) makes investments common to a broad range of science and engineering fields, promoting economies of scale and scope, and facilitating interoperability. Other directorates and offices make complementary cyberinfrastructure investments necessary to meet their missions. Some highlights of NSF's FY 2008 investments, led by the designated activity, follow:

- Investments in a Plant Science Cyberinfrastructure Collaborative (PSCIC) will create a new type of organization – a cyberinfrastructure collaborative for plant science – that will enable new conceptual advances through integrative, computational thinking. The collaborative will utilize new computer, computational science, and cyberinfrastructure solutions to address questions in plant science. The collaborative will be community-driven, involving plant biologists, computer and information scientists, and experts from other disciplines working in integrated teams. (BIO)

- As part of the Science of Science Policy initiative, there will be a focus on (a) new techniques of data extraction leading to new science and engineering indicators and (b) the development of virtual collaboratories where social and behavioral scientists will work with scientists in specific domains in seeking to understand how to evaluate investments made in those disciplines or problem areas. In addition, the Innovation and Organizational Change program will focus attention on the effects of innovative cyberinfrastructure on companies and scientific laboratories. (SBE)

- Support will be provided to initiate the development of a versatile, open-source, community Ocean Modeling Environment and to identify and refine best practices and describe trade-offs between alternatives for simulating a range of important ocean processes. A second thrust is to develop and assess the capability to dynamically configure the grid resolution of future ocean models. The Budget Request also supports work at the Southern California Earthquake Center utilizing the TeraGrid to construct physics-based, realistic models of earthquake wave propagation in southern California and to begin the creation of a system of models that simulate the production, transport and deposition of sediments. Both projects will have considerable societal impacts. Finally, the Request supports a variety of projects that will develop or maintain community databases. (GEO)

- The National Center for Earth Surface Dynamics (NCED), an NSF Science and Technology Center, will examine the processes that contribute to land loss in the Mississippi Delta region. The project aims to leverage the vast array of petroleum seismic images and detailed knowledge of how deltaic systems function to examine how human engineering of the Mississippi River is contributing to the loss of wetlands. Such land loss is believed to have contributed significantly to damage caused by hurricane Katrina by removing barrier islands that normally would have helped dissipate some energy and resulted in a smaller storm surge. Such knowledge could be used in the future to plan geologically realistic restoration schemes for the delta and will be of great value in similar regions, both in the U.S. and abroad. (GEO)

- Support will be provided for software and services that facilitate complex science and engineering research and that advance ACI goals in data-intensive applications. These include innovative approaches to data management and middleware for distributed applications, distributed collaboration, interactive remote observation and the tele-operation of experimental facilities. Continued investment in leading-edge computational infrastructure and international network connections will support the research of U.S. investigators and their ability to collaborate internationally in projects such as the Large Hadron Collider (LHC). Investments will be made in numerical models, data analysis tools and new algorithms in strategic science and engineering research areas in order to take advantage of forthcoming petascale computing systems. (OCI)

- Support will be provided for the continuing design and development of the Global Environment for Networking Innovations (GENI). GENI cyberinfrastructure is being developed by the computing community to support fundamental research in networking and distributed systems essential to fully inform redesign of the internet to incorporate security, robustness, and openness into technological innovation. GENI will bridge the gap between physical and virtual worlds by including mobile, wireless, and sensor networks and will enable control and management of other critical infrastructures. (CISE)

- 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 to evolve NSDL as a component of cyberinfrastructure-enabled learning cooperatives for discovery-based learning. (EHR)

- Improved understanding and design approaches will be pursued for auto-reconfigurable engineered systems enabled by cyberinfrastructure. Autonomous reconfigurability is a promising concept for ensuring appropriate operational levels during and after unexpected natural or man-made events (e.g. hurricanes, pandemics, or terrorist attacks) that could impact critical engineered systems in unforeseen ways. (ENG)

- The International Geophysical Year (IGY: 1957-1958) or International Polar Year (IPY-3) ushered in the modern era of polar research and provided the first detailed measurements of the polar ocean, atmosphere, land, and space. Emerging advances in cyberinfrastructure that occur during the IPY (2007-2008) will for the first time link remote instruments with scientists in the field and institutions around the world, allowing scientists to observe and record the pulse of our planet in real-time. (OPP)

- Cyberinfrastructure support will also 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 environmental monitoring, both marine and terrestrial. Improved communications and digitized data infrastructure to enhance exploitation of astrophysical data collected from South Pole Station during IPY will be implemented. In addition, support is provided for the engineering, operations and maintenance, and security of cyberinfrastructure systems. (OPP)

- Emphasis will continue on the development of global GRID network technology to enable discoveries to be made in petabyte data sets generated at unique facilities and involving international collaborations, e.g., LIGO and LHC. (MPS)

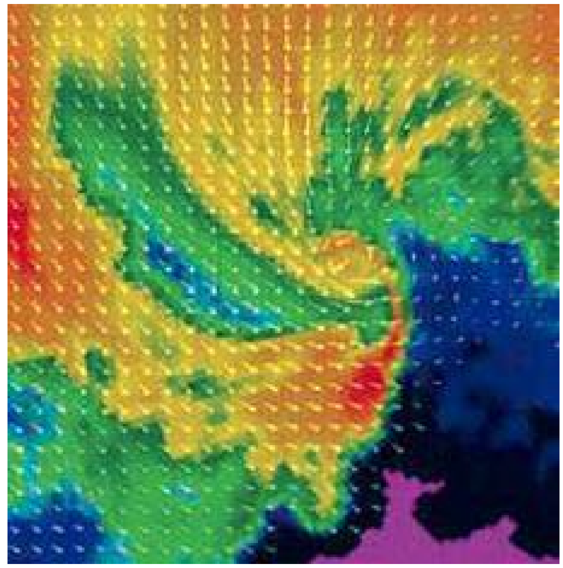
- Physical scientists and mathematicians create and use cyberinfrastructure, contributing to the development of high-performance computing, high-speed networks, data mining, software, and algorithms. Research at the frontiers of mathematical and physical sciences spans multiple length and time scales, and encompasses elementary particles; nuclear, atomic, and molecular properties, dynamics, and reactions; discovery of new materials and states of matter; complex multiscale systems and emergent behavior; supernovae and structures in the universe; and gravity waves and spacetime. Achieving a fundamental understanding of these diverse phenomena advances research both for itself and at the interfaces with the life sciences and the environment, contributes to the intellectual foundations of future cyberinfrastructure, and stimulates national competitiveness. (MPS)

- The innovative creation and use of cyberinfrastructure enables the prediction and discovery of new materials and new states of matter. It also enables the understanding of related phenomena. Software and algorithm development continue to be key to opening new approaches to reliably predict the properties of materials and phenomena, including those spanning many scales of length and time. The judicious and innovative use of cyberinfrastructure ensures community access to the best software for a wide range of research activities from the interpretation of experimental data to the visualization of simulation results for steering and interpretation to the creation of “virtual materials.” Advances in the performance of information technology hardware bring previously computationally intractable or impractical methodologies or analyses within reach to tackle problems at the frontiers. (MPS)

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

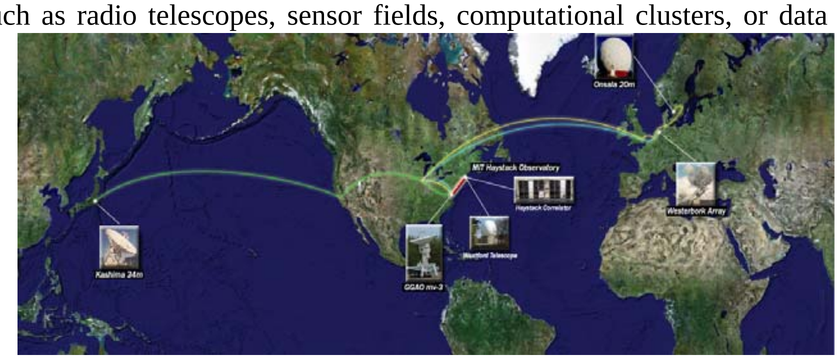
► **Reliable Tornado Prediction:** Current radar systems often miss tornadoes or confuse them with other short-lived weather events. Weather radar cannot accurately detect low-altitude activities such as tornadoes or distinguish between tornadoes and transient low-shear regions within other storms. So tornadoes must be confirmed visually. By the time a tornado has been identified, it is often too late to protect the people and structures in its path.



A simulation using the tornado detection algorithm. The swirling flow in the right–center of the image shows the tornado. *Credit: CASA ERC, University of Massachusetts-Amherst.*

Researchers at the Center for Collaborative Adaptive Sensing of the Atmosphere (CASA), an Engineering Research Center headquartered at the University of Massachusetts, Amherst, are focused on this issue. They have begun installing a network of low-power Doppler weather radar and have developed the first algorithms for dynamically detecting tornadoes close to the ground. The algorithms integrate wind field data from various radars and reconstruct the 3D wind field to define a tornado "signature". The algorithms identify tornadoes automatically and then provide information to optimize radar scanning to effectively track storms as they evolve. This allows weather forecasters to better predict the areas that will be affected by tornadoes, saving lives and property. (ENG)

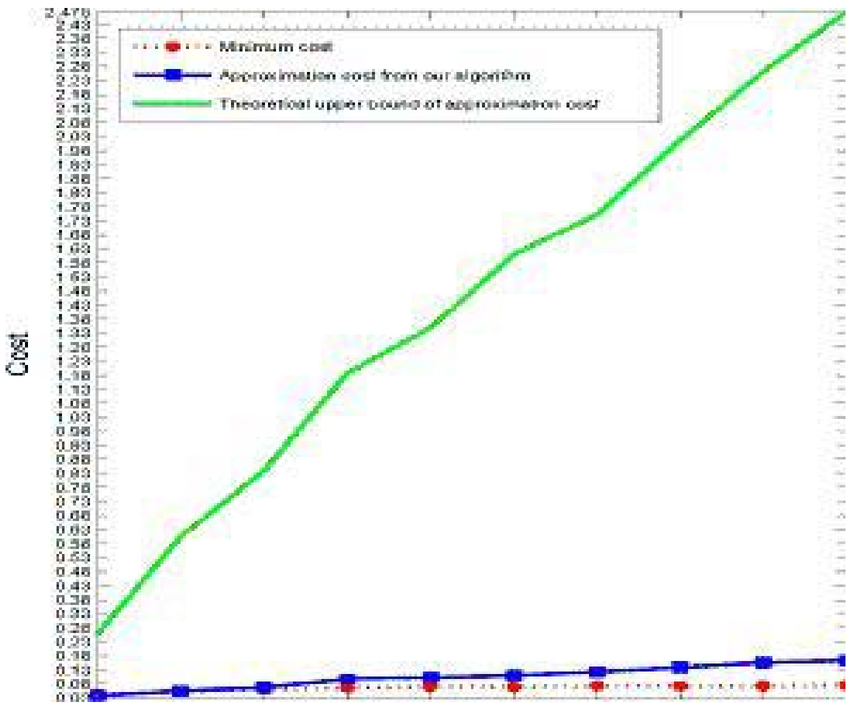
► **DRAGON (Dynamic Resource Allocation via GMPLS Optical Networks):** Scientists of the DRAGON networking research project have developed advanced network technologies that allow emerging "e-science" applications to construct customized and dedicated networks linking scientific resources worldwide. Resources such as radio telescopes, sensor fields, computational clusters, or data repositories can be integrated into a single coherent tool available to an individual scientist or science team. The networks can be established in a matter of seconds, when and where needed, held for as long as needed, and then released when no longer required.



Linking radio telescopes for Very Long Baseline Interferometry studies.

DRAGON research combines pre-commercial technology, tiny mirrors etched into integrated circuits and used to switch very high-speed photonic telecommunications channels, and Generalized Multiprotocol Label Switching (GMPLS) technology, a set of software protocols that automate the set-up process for these channels. Reconfigurable optical add/drop multiplexers provide an automated means to reconfigure optical networks dynamically and efficiently. These capabilities have been refined as a direct result of the DRAGON collaboration and the resulting switching devices have been deployed in advanced research and commercial carrier networks worldwide. GMPLS protocols, while standardized, had not seen significant adoption until they were deployed, with extensions for the global environment, in the DRAGON network. Today, DRAGON GMPLS software is deployed in the U.S. and in Europe and Japan. Leveraging this reach, researchers at MIT Haystack Observatory link radio telescopes and correlation facilities in Massachusetts, Maryland, Europe and Japan for groundbreaking Very Long Baseline Interferometry studies. Other corporations, agencies, and universities actively and tangibly support DRAGON development. The visibility and viability of these technologies in a high-profile testbed has spurred development and/or deployment well beyond the initial collaborating organizations. The NSF DRAGON project is the seed around which the rest of the global lattice is crystallizing. (OCI)

► **Minimum Cost Sensor Wireless Coverage:** A wireless sensor network monitors a given area by using small sensing devices that communicate amongst themselves using wireless communication. To adequately sense the physical world, sensors are typically deployed in numbers ranging from tens-to-thousands. Now, to ensure complete monitoring at a minimal cost, computer scientists have devised a computational method to optimize sensor placement in the area to be covered.



Computer scientists developed a new method to ensure complete coverage in a wireless sensing field at minimum cost. *Credit: Jie Wang.*

Wireless sensor networks offer new solutions for the 3-dimensional monitoring of varied settings including rainforests, oil platforms, bridges, city blocks, and high-rise buildings. To adequately monitor a sensing field and build in a safety factor in the event a sensor in the network fails, several sensors may be needed for every viewing point. Accordingly, the new method also calculates when certain sensors can "sleep" in order to save energy and increase the working lifespan of sensors in the network. (CISE)

HUMAN AND SOCIAL DYNAMICS

The Human and Social Dynamics (HSD) investment 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 a competitive and innovative workforce, has at its core important human and social dynamics. New technologies, such as high-speed computers, remote sensing 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 towards understanding the processes that shape individual, organizational, and social action. HSD builds upon unprecedented opportunities for fruitful synergies across the social and behavioral sciences and with other fields of science 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 investment area's crucial defining elements. HSD focuses on human beings, with special attention to both individual behavior and cognition and to 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. Interactions and feedbacks in these dynamic systems are not adequately captured by standard linear models and transcend traditional disciplinary boundaries, mandating collaborations across the breadth of the sciences.

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 investment area requires research by interdisciplinary teams, and encourages international collaborations that link researchers from SBE science disciplines with those from other science and engineering disciplines.

Human and Social Dynamics Funding
(Dollars in Millions)

	FY 2006	FY 2007	FY 2008	Change over FY 2007	
	Actual	Request	Request	Amount	Percent
Biological Sciences	$0.50	$0.50	$0.50	-	-
Computer and Information Science and Engineering	3.02	5.00	2.00	-3.00	-60.0%
Engineering	2.00	2.00	1.50	-0.50	-25.0%
Geosciences	1.35	1.35	1.35	-	-
Mathematical and Physical Sciences	0.50	0.50	0.50	-	-
Social, Behavioral and Economic Sciences	31.40	31.40	31.40	-	-
Office of International Science and Engineering	0.50	0.50	0.50	-	-
Office of Polar Programs	0.20	0.20	0.20	-	-
Total, Human and Social Dynamics	$39.47	$41.45	$37.95	-$3.50	-8.4%

Totals may not add due to rounding.

This investment area began in FY 2003 within the Social, Behavioral, and Economic Sciences Directorate (SBE). In FY 2004, the first full year of HSD, it expanded to reach across all NSF science and engineering disciplines. In response to the large number of meritorious submissions, NSF has increased the funds available in each subsequent year until FY 2007.

Increased funding allowed NSF and HSD to respond quickly to the East Indian Tsunami in December 2004 and Hurricane Katrina in August 2005. Several HSD awards were made using the NSF Small Grants for Exploratory Research (SGER) mechanism, which is designed to allow researchers to engage in time-sensitive data collection and research. After Hurricane Katrina, 187 HSD SGER proposals were received, resulting in 33 awards. Funded projects included studies investigating ways to improve disaster response efforts; how the physical/built environment influences a region’s vulnerability to hurricanes; which populations evacuate and which do not; and how schools in nearby regions cope with large, sudden influxes of students.

In the FY 2006 competition, 342 Exploratory Research and Research Community Development (ERCD) and Full Research proposals were considered, and SBE made 90 awards, yielding a success rate of 26 percent. This most recent set of HSD awards includes research on how the interplay of federal and state government policies influence responses to extreme events, including terrorist activities; how humans respond to natural, technological, and human disasters, with the goal of better planning for disasters and improving management and recovery efforts; how institutions and organizations can learn from and respond to environmental threats; how computer-mediated environments affect the production and practices of deception in order to improve methods for detecting and countering deception; and how distance and leadership configurations influence team dynamics in partially distributed teams.

Annual Principal Investigator meetings, which began in FY 2005, are showing substantial results and interesting insights across many domains.

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 biological, 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.

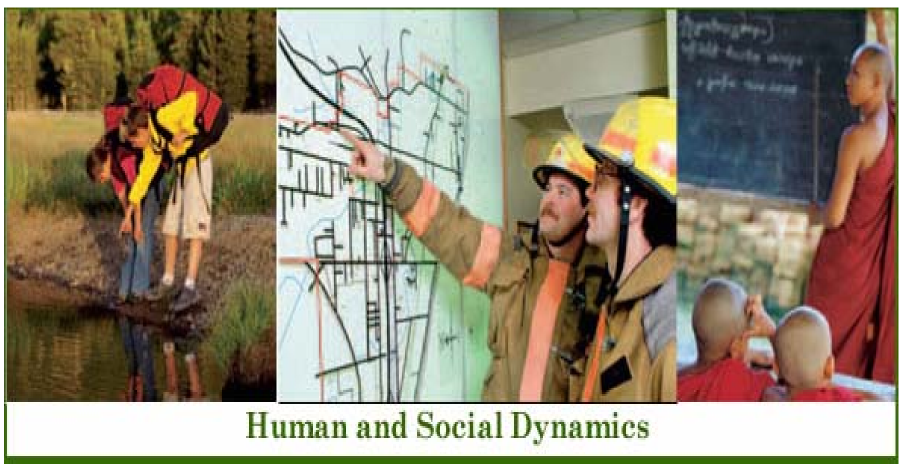
- Significantly advance data resources and stimulate new problem definitions and framings within which novel research techniques can be tested and put into practice.

Long-term Funding for Human and Social Dynamics
(Dollars in Millions)

FY 2003 Actual	FY 2004 Actual	FY 2005 Actual	FY 2006 Actual	FY 2007 Request	FY 2008 Request	FY 2009 Estimate
$4.46	$30.07	$38.31	$39.47	$41.45	$37.95	$37.95

Estimate for 2009 does not reflect policy decisions and is for planning purposes only.

FY 2008 Areas of Emphasis: In FY 2008, NSF plans to invest $37.95 million in interdisciplinary research on *Human and Social Dynamics,* a $3.50 million decrease compared to the FY 2007 Request of $41.45 million. 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 2007 – FY 2008 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.



- **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 as well as organizational requisites for innovative action, 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 the work place.

- **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 testbeds 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, have led to the use of 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 investment area to students at all levels.

In FY 2009, the last year of the HSD program, NSF plans to invest $37.95 million in HSD activities as shown above. In future years, these activities will be part of ongoing programs in the participating areas. There is strong commitment for continuation of interdisciplinary HSD related-partnerships.

Recent Research Highlight

► **The Eyes Have It Over Words for Rapid, Complex Communication:** Speech is the single most-powerful mode for coordinating human activities. But it is not always the best mode, especially in time-critical situations that require conveying complex messages or spatial information. Words must still be said one after the other, no matter how fast one talks, and spatial information is notoriously difficult to articulate.

This can create problems during natural disasters or terrorist attacks, when responders must interact as a coordinated unit, when decisions need to be made quickly, and when collaborations are occurring at a distance via the Internet and multimedia devices.

To help meet that challenge, Stony Brook University psychologist Gregory Zelinsky and his coworkers have developed a method that allows remotely located collaborators to monitor each other's focus of attention by tracking their eye movements. Lightweight head-mounted eye-trackers transmit the users' gaze positions to their partners' computer displays, where the positions appear as moving cursors. Each collaborator is therefore able to see, in near real time, where everyone else is looking.

Using this shared gaze technology, the researchers established that collaborators quickly learn to coordinate their looking behavior. Moreover, when shared gaze was pitted against speech in a time-critical task, shared gaze was the clear winner—by 30 percent in one experiment. In another experiment, shared gaze halved the time that it took one collaborator to verbally communicate a target’s location to her partner.

Zelinsky and his coworkers envision the day when eye-trackers located unobtrusively on desktops or integrated into wearable displays will allow teams of analysts, decision makers, soldiers, secret service agents, search and rescue workers, or first responders to collaborate more efficiently.

INTERNATIONAL POLAR YEAR

The International Polar Year (IPY) in 2007-2009 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.

In FY 2008, NSF will continue funding IPY research, infrastructure, and education. NSF's approach addresses the challenges posed by the U.S. National Academies of Science (NAS) in its vision document for IPY. The approach addresses 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). It supports the goals of the American Competitiveness Initiative (ACI) by contributing to and stimulating an array of learning opportunities for citizens of all ages by linking our activities to those in other countries.

IPY provides a framework and impetus to undertake research projects that normally could not be achieved by any single nation. It allows thinking 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.

The vision for IPY established by the NAS 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 will provide U.S. leadership in IPY through the work of its grantees, in coordination with other agencies, and by developing partnerships with other nations. In FY 2006, emphasis was placed on establishing an Arctic Observing System in support of the Study of Environmental ARctic CHange (SEARCH), on Polar Ice Sheet Dynamics and Stability, and on studies of Life in the Cold and Dark, particularly at the genomic level. Work in FY 2007 and FY 2008 builds on these themes and expands to new ones identified in research community planning activities.

One major NSF IPY focus will be on climate change research and environmental observations. Much of the research supported under IPY will be consistent with and supportive of the goals of the U.S. Climate Change Science Program, particularly Goal 1, "Extend knowledge of the Earth's past and present climate and environment, including its natural variability, and improve understanding of the causes of observed changes," and Goal 2, "Improve understanding of the forces bringing about changes in the Earth's climate and related systems." Work will include observations, data, analysis, models, and natural and social science research to strengthen our ability to understand and respond to global environmental issues. Climate change research and environmental observations are highlighted as an R&D priority under "Environment." An important NSF IPY focus associated with climate change will be on Humans in the Arctic. In most instances, U.S. scientists' efforts will be leveraged by the related efforts of international scientists.

Another major focus will be on the interagency FY 2008 R&D priority, "Understanding Complex Biological Systems," through research that enables advances in understanding how life adapts and survives the polar dark, with emphasis on the cellular and genomic levels but reaching to human impacts as well. Using new biological tools and generating increasing amounts of genetic sequence data and information, this work will pave the way for new discoveries about the functional implications of gene expression.

A third focus of IPY will be maintaining existing standardized data sets, creating new scientific collections, and ensuring their availability to current and future generations of researchers. These will help frame the answers to current and as yet unknown questions. Led by NSF's Office of Polar Programs (OPP), several of NSF's disciplinary-based research directorates, NSF's Directorate for Education and Human Resources, and the Office of International Science and Engineering will participate actively in this work. IPY provides an ideal opportunity to involve students in international research ventures.

IPY will also involve people of all ages, from all walks of life, and from diverse backgrounds – from teachers to students and artists to scientists – engaging them in the scientific discoveries that will evolve from this international, collaborative research venture. Teacher enhancement programs will increase the number of qualified math and science teachers. Through education and outreach, the importance of science and engineering in understanding earth systems will be showcased.

International Polar Year Funding

NSF funding for IPY activities in FY 2007 and FY 2008 will be administered by OPP in collaboration with other NSF offices and directorates. These will build on a number of ongoing NSF programs throughout the agency and the OPP core investments designed to facilitate world leadership in this worldwide activity. NSF's IPY FY 2008 request totals $58.67 million.

IPY investments will 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. NSF's investments will improve the infrastructure for research at the Long Term Ecological Research sites at Toolik Lake, Alaska, in the Antarctic Dry Valleys, as well as at the Barrow, Alaska, Global Climate Change Research Facility, and at NSF's research station in Summit, Greenland. These improvements will enable fundamental research in biology and ecology into the polar winter months.

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 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Biological Sciences (BIO)	-	$2.00	$2.00	-	-
Geosciences (GEO)	-	5.00	5.00	-	-
Office of International Science & Engineering (OISE)	-	0.30	0.40	0.10	33.3%
Office of Polar Programs (OPP)	10.00	47.27	47.27	-	-
Social, Behavioral and Economic Sciences (SBE)	2.40	5.00	2.00	-3.00	-60.0%
Subtotal, Research and Related Activities (R&RA)	12.40	59.57	56.67	-2.90	-4.9%
Education and Human Resources (EHR)	2.95	2.00	2.00	-	-
Total, IPY Funding	$15.35	$61.57	$58.67	-$2.90	-4.7%

FY 2008 Areas of Emphasis:

BIO will support research that addresses scientific challenges such as biological adaptation and ecosystem dynamics in polar environments using genomics tools. Support for research on the understanding of environmental change and biotic systems in the polar regions will continue in FY 2008.

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. Both Arctic and Antarctic observations of the polar upper atmosphere will be emphasized in order to better understand space weather. This research will use the new Advanced Modular Incoherent Scatter Radar in Alaska and at Resolute Bay, Canada.

OISE will partner with other NSF research directorates and offices through the agency-wide focused program and with foreign research organizations to catalyze international collaborations on polar research in support of IPY.

OPP will support a special-focused competition for IPY as well as a broad range of individual innovative projects that respond 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 Antarctic Ice Sheet, thus allowing incorporation of these data into developing mathematical models of ice sheet dynamics; 3) provide funds for genomics in polar biology, and 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; 4) support, in collaboration with EHR, activities in informal and formal education to raise public awareness of the importance of the polar regions to understanding our changing planet; 5) initiate, with SBE, a new focus on Humans in the Arctic; and 6) provide essential logistics and infrastructure improvements needed to implement activities planned for IPY.

SBE will support research on human adaptation and change within polar environments that focus on human-environment interactions from a range of perspectives. Human adaptations reflected in native languages and cultures will be documented. Furthermore, social and economic aspects of nutrition, mental well-being, and infectious diseases will also be examined. Although SBE is reducing its participation by $3.0 million, it will continue to augment its IPY investments through related core activities. Through its "gold-standard" General Social Survey (GSS), SBE provided specific questions in 2006 that addressed Americans' knowledge of the polar regions. SBE plans to continue this series of questions so as to provide longitudinal data on this topic.

EHR supports coordination and communication for IPY education projects. These will support formal science education experiences for K-12 teachers and undergraduate and graduate students, and informal science education for the broader public.

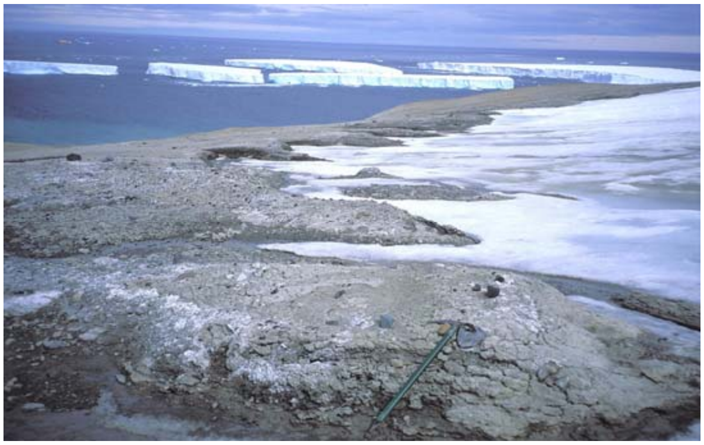
In all these activities, NSF will provide funds for the collection and maintenance of legacy information using cutting-edge data management methods and shared access to the data products resulting from IPY activities. Each will be linked to NSF's education and outreach IPY goals and will be implemented 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 and educate diverse audiences of all ages in 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. K-12 educators, and graduate and undergraduate students will be included as members of polar science teams. Teachers will be enabled to bring polar research to their classrooms to inspire the interest of the next generation of scientists in international, collaborative research about the polar regions.

Recent Research Highlight

► **Collapsing ice shelf reveals seafloor life:** Researchers have discovered an entirely unexpected ecosystem in the lightless depths just off the coast of the Antarctic Peninsula. When the Larsen B Ice Shelf collapsed there in 2002, it suddenly revealed the seabed beneath, giving NSF-supported scientists a chance to survey the contents. They found marine life forms, such as thick bacterial mats, that were able to subsist without sunlight – which had been blocked by the ice above – and therefore without photosynthesis.



View of basal glacial debris (marginal moraine of Robertson Island Ice Cap) on top of Cretaceous outcrop on Cape Marsh, Roberston Island. View in background of grounded tabular icebergs from penultimate collapse of Larsen B ice shelf, coastal meltwater plumes and *R\V Nathaniel B. Palmer*. Picture taken December, 2001. *Credit*: *Eugene Domack.*

Such communities, called "chemotrophic" because their members obtain energy from oxidation of chemical compounds rather than deriving it from sunshine, had previously been seen only at warm volcanic locations and hydrothermal vent areas on the sea floor. Eugene Domack of Hamilton College and colleagues described their findings in publications during 2005. The scientists speculate that the bacteria may feed on seepage of methane gas from the seabed. The research also serves to further understanding of how ice shelves collapse, as well as providing insight into potential sea level change associated with global warming.

View of remnant tabular iceberg (from Larsen B) in front of the new fjord coast of Oscar II Land (taken February, 2005). *Credit*: *David Tewksbury*.

NATIONAL NANOTECHNOLOGY INITIATIVE

NSF's contribution to the multiagency National Nanotechnology Initiative (NNI) encompasses the systematic understanding, organization, manipulation, and control of matter at the atomic, molecular, and supramolecular levels in the size range of 1 to 100 nanometers. Novel materials, devices, and systems – with their building blocks designed on the scale of nanometers – open up new directions in science, engineering, and technology with potentially profound implications for society. With the capacity to control and 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 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
Biological Sciences	$49.00	$52.55	$55.55	$3.00	5.7%
Computer and Information Science and Engineering	10.42	12.87	11.00	-1.87	-14.5%
Engineering	127.77	137.02	139.02	2.00	1.5%
Geosciences	9.00	9.65	9.65	-	-
Mathematical and Physical Sciences	158.24	156.42	169.91	13.49	8.6%
Social, Behavioral and Economic Sciences	1.56	1.67	1.67	-	-
Office of International Science and Engineering	0.48	-	-	-	-
Subtotal, Research and Related Activities	$356.47	$370.18	$386.80	16.62	4.5%
Education and Human Resources	3.24	3.00	3.10	0.10	3.3%
Total, National Nanotechnology Initiative	$359.71	$373.18	$389.90	16.72	4.5%

FY 2008 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.

(1) Fundamental nanoscale phenomena and processes. The FY 2008 Request includes $142.67 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. A focus will be on understanding and use of self assembly from basic principles and on multiple scales. Potential applications include use of quantum phenomena in systems and 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. A focus will be on understanding and simulation of cells, tissues, and nervous systems, with application to biomedicine and neuromorphic engineering.
- *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. A special focus will be on simulations with atomic precision, time resolution of chemical reactions, and for domains of engineering and biological relevance.

(2) Nanomaterials. The FY 2008 Request includes $60.19 million for discovery of novel nanoscale and nanostructured materials, and improving the comprehensive understanding of the properties of nanomaterials (ranging across length scales and including interface interactions). A special focus will be gaining control of nanoscale features and devices with the atomic level of precision. Another focus will be 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, catalysts, energy, healthcare, and manufacturing.

(3) Nanoscale devices and systems. The FY 2008 Request includes $51.10 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. A special focus will be on nanomanufacturing of active nanostructures and nanosystems.

Nanoelectronincs beyond silicon nanotechnology and complementary metal-oxide superconductors (CMOS) 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, bottom-up device assembly technologies at the atomic and molecular levels, and new system architectures using nanoscale components.

A special focus will be on nano-informatics for better communication and nanosystem design. It includes defining the ontology of terms, interconnecting databases, using specific informatics tools, and connecting to bioinformatics.

(4) Instrumentation research for nanotechnology. The FY 2008 Request includes $14.50 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. A special challenge is developing tools for measuring and restructuring matter with atomic precision, for time resolution of chemical reactions, and for domains of biological and engineering relevance.

(5) Nanomanufacturing. The FY 2008 Request includes $26.90 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 is aimed at enabling scaled-up, reliable, cost effective manufacturing of nanoscale materials, structures, devices, and systems. A special focus will be creating active nanostructures and complex nanosystems. This will include R&D and integration of ultraminiaturized 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.

(6) Major research facilities and instrumentation acquisition. The FY 2008 Request includes $31.62 million for 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), Network for Computational Nanotechnology (NCN) and National Network for Nanomanufacturing. The investment will support facilities for 16 ongoing Nanoscale Science and Engineering Centers (NSEC).

(7) Societal Dimensions. The FY 2008 Request includes $62.92 million, an increase of $3.90 million over FY 2007, 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 ($28.75 million). Research will address the 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 nanoparticles 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). New measurement methods for nanoparticle characterization and toxicity of nanomaterials will be investigated. Support is requested for a new multidisciplinary center to conduct fundamental research on the interactions between nano-particles and materials and the living world at all scales. An essential element of this will be research on methods and instrumentation for nano-particle detection, characterization, and monitoring, including interactions of nano-materials with cellular constituents, metabolic networks and living tissues, bioaccumulation and its effects on living systems, and the impacts of nanostructures dispersed in the environment. This work will support regulatory and mission agencies in developing science-based standards for risk assessments, such as the standards needed by the EPA to regulate nano-materials.
- 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 ($28.38 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 ($5.79 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 be fully operational in FY 2008.

Coordination with Other Agencies

The NSF program is coordinated with 25 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/NIEHS/ USDA); NSECs, NNIN and NCN centers and networks (DOD/NASA/DOE/NIH); simulations in nanoelectronics (DOD/NASA); and research and training activities (DOD/NIH).

NNI by Program Component Area

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
Fundamental Nanoscale Phenomena & Processes	$147.34	$131.84	$142.67	$10.83	8.2%
Nanomaterials	52.52	57.97	60.19	2.22	3.8%
Nanoscale Devices & Systems	43.68	50.26	51.10	0.84	1.7%
Instr. Research, Metrology, & Standards for Nanotech	6.59	15.00	14.50	-0.50	-3.3%
Nanomanufacturing	20.31	27.24	26.90	-0.34	-1.2%
Major Research Facilities & Instrumentation Acquisition	37.20	31.85	31.62	-0.23	-0.7%
Societal Dimensions: Environmental Health & Safety	21.03	25.65	28.75	3.10	12.1%
Societal Dimensions: Education	25.00	28.00	28.38	0.38	1.4%
Societal Dimensions: Ethical, Legal and Other Social Issues	6.03	5.37	5.79	0.42	7.8%
Total, National Nanotechnology Initiative	$359.71	$373.18	$389.90	$16.72	4.5%

Totals may not add due to rounding.

NETWORKING AND INFORMATION TECHNOLOGY R&D

The National Science Foundation is a primary federal agency supporting the Networking and Information Technology Research and Development (NITRD) program. 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 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
Biological Sciences	$77.00	$83.50	$83.50	-	-
Computer and Information Science and Engineering	496.35	526.69	574.00	47.31	9.0%
Engineering	11.20	11.20	21.20	10.00	89.3%
Geosciences	14.56	14.56	14.56	-	-
Mathematical and Physical Sciences	68.93	69.00	76.96	7.96	11.5%
Social, Behavioral and Economic Sciences	12.47	12.47	14.47	2.00	16.0%
Office of Cyberinfrastructure	127.14	182.42	200.00	17.58	9.6%
Subtotal, Research and Related Activities	807.65	899.84	984.69	84.85	9.4%
Education and Human Resources	3.88	3.90	9.00	5.10	130.8%
Total, NITRD Request	$811.53	$903.74	$993.69	$89.95	10.0%

NSF's FY 2008 Request continues strong support for the NITRD program, most notably through NSF's new investment in Cyber-enabled Discovery and Innovation (CDI). This initiative aims to explore radically new concepts, approaches, and tools at the intersection of computational and physical or biological worlds. CDI is comprised of five conceptual areas - knowledge extraction, interacting elements, computational experimentation, virtual environments, and education for computational discovery. This five-year initiative is led by the Directorate for Computer and Information Science and Engineering and is supported by several other NSF directorates and the Office of Cyberinfrastructure.

The NITRD Request of $993.69 million supports fundamental research, development, 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;
- Cyber security and information assurance (CSIA) 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 R&D community;
- Large-scale networking (LSN) for federal high-performance networking R&D in leading-edge networking technologies, services, and enhanced performance;
- 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;
- 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 as well as interactions between people and IT devices and capabilities as well as workforce development needs.

NSF works in close collaboration with other NITRD agencies and participates at the co-chair level in seven of the eight PCA Coordinating Groups. NSF's Assistant Director for Computer and Information Science and Engineering is co-chair of the NITRD Subcommittee of the National Science and Technology Council's Committee on Technology.

NITRD Priorities in FY 2008

In addition to the Cyber-enabled Discovery and Innovation investment described previously, NSF is emphasizing investments in the following areas of NITRD in FY 2008:

Large Scale Networking ($106.70 million): CISE will increase support for pre-construction planning activities for the Global Environment for Networking Innovations (GENI), including support for the GENI Project Office. GENI will provide computing researchers with world-class experimental opportunities that substantively transform research in networking and distributed systems.

Cybersecurity and Information Assurance ($69.15 million): Support will continue for several centers, including one devoted to the scientific exploration of new technology that will radically transform the ability of organizations to design, build, and operate trustworthy information systems for critical infrastructure, and one investigating software architectures, tamper-resistant hardware, cryptographic protocols and verification systems as applied to electronic voting systems.

High-End Computing R&D ($67.06 million): 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 Infrastructure and Applications ($303.09 million): Continuation of the acquisition of a high performance computing system in the Office of Cyberinfrastructure is included at an annual level of $50 million. Several NSF directorates will increase their investments in this PCA to capitalize on the growing importance of cyberinfrastructure in furthering their research and education goals. For example, MPS and ENG will increase activity in modeling and simulation of complex systems; development of numerical algorithms and software implementations that push the boundaries of computing infrastructure; and use of the grid computing infrastructure.

MPS will strengthen support of research and education activities that contribute to and utilize the Virtual Astronomical Observatory, a federation of astronomical data bases. Support of other databases and digital libraries also will increase. MPS will support enhanced participation of remote access to instrumentation and increased connection of institutions that are distant from each other, such as a minority institution and its partner.

ENG will increase support of virtual organizations to leverage distributed physical experimentation, data collection, modeling and analysis capabilities using high-end computing and large scale networking infrastructures. ENG will also increase activity in modeling and simulation of complex systems; development of numerical algorithms and software implementations that push the boundaries of computing infrastructure; and use of the grid computing infrastructure.

BIO will invest in activities to broaden access to and usability of high performance computing resources in the biological sciences. While biology applications claim a substantial amount of HPC computing resources, those applications cover a narrow slice of all of biology. With increasing availability of large amounts of data, from genome data to ecosystems modeling, more areas of biology will need to have access to HPC resources.

GEO will continue support of the Climate Simulation Laboratory (CSL) at the National Center for Atmospheric Research. CSL provides state of the art computing systems and data management services, helping to keep the U.S. at the forefront of 21st century climate science.

<u>High Confidence Software and Systems ($57.44 million)</u>: CISE will increase support for research on computing processes and artifacts and computer systems research for high-confidence embedded systems, hybrid control, and distributed systems.

ENG will increase support of research on novel processor architectures, high density memory and storage devices, and resilient networking tools to enable high confidence systems.

<u>Human Computer Interaction and Information Management ($225.62 million)</u>: NSF will focus increased attention on the issues of federation, preservation, curation, and access to large, heterogeneous collections of scientific data and information. High capacity data management and high capacity computing are increasing challenges for a growing number of research communities. Funding in this area is increased to address the limitations of current tools. BIO's investments in this area will facilitate discovery through tools that integrate the published literature with the expanding universe of digital data collections, expand capacity for understanding through virtual environments that provide an intuitive display of the complex networks of interactions among organisms and their environments, and make it practical for scientists to search vast collections of biological images simply and quickly.

<u>Software Design and Productivity ($55.31 million)</u>: CISE will increase its investments in software design and productivity. With software development reaching the limits of technologies developed over the last 50 years, innovative theories, methods, and tools will be developed. Computational models for software are now just emerging and will be incubated with focused funding and supportive demonstration environments. While much of the research focus during the first 50 years of computing was on correct syntax-directed computation of details for computer execution, the focus of the next 50 years will shift to semantics-directed computation of correct abstractions for human understanding and manipulation.

BIO, through its Biological Databases and Informatics program, will promote new ways of enabling science through the use of cyberinfrastructure, including new visual programming environments and integrated information systems that allow an entire community of experts to contribute simultaneously to understanding genome dynamics.

<u>Social, Economic and Workforce ($109.32 million)</u>: CISE will continue to support 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. In addition, through a new internationally-focused program, CISE will contribute to the development of a competitive, *globally aware* workforce. This program will increase the computing research community's engagement in key nation states and regions.

In collaboration with partners across the Foundation, OCI will support creative explorations and demonstrations of the use of cyberinfrastructure to integrate research with education, the development of innovative technologies that will facilitate the integration of research and education, and research on how educators and students interact with cyberinfrastructure along with exploring novel uses of cyberinfrastructure.

BIO will strengthen IT capabilities in all biological sub-disciplines through support for postdoctoral fellowships in bioinformatics; integrative graduate programs that combine training in biology and computer sciences (via the NSF-wide IGERT program); undergraduate summer institutes in bioinformatics through the interagency Bioengineering and Bioinformatics Summer Institutes program (BBSI); and other mechanisms.

EHR will continue to study the impact of IT on educational practice, new approaches to using technology in education, application and adaptation of technologies to promote learning in a variety of fields and settings, and the effects of technology on learning. EHR's support for the new NSF-wide Cyber-enabled Discovery and Innovation investment will include funding of proposals that study the impact of information technology on educational practice, new approaches to using technology in education, application and adaptation of technologies to promote learning, the effects of technology on learning, and up to four new CREST centers that target nanotechnology and/or cyberinfrastructure.

NITRD by Program Component Area
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
Large Scale Networking	$87.50	$84.00	$106.70	$22.70	27.0%
Cybersecurity and Information Assurance	54.78	67.57	69.15	1.58	2.3%
High End Computing R&D	64.16	64.13	67.06	2.93	4.6%
High End Computing Infrastructure and Applications	221.12	272.35	303.09	30.74	11.3%
High Confidence Software and Systems	42.11	51.25	57.44	6.19	12.1%
Human-Computer Interaction and Info Management	198.06	220.85	225.62	4.77	2.2%
Software Design and Productivity	50.56	50.69	55.31	4.62	9.1%
Social/Economic/Workforce	93.25	92.90	109.32	16.42	17.7%
Total, NITRD Request	$811.53	$903.74	$993.69	$89.95	10.0%

Totals may not add due to rounding.

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 $19.53 million for ADVANCE in FY 2008, a decrease of $190,000 from the FY 2007 Request, will fund transformative efforts to address the systemic barriers to women's full participation in academic science and engineering (S&E). Included in the 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 Institutional Transformation. In order to include a variety of institutional types, new catalytic awards (IT-Start) will be made to support basic data collection and analysis functions necessary to understand the status of women faculty in academic S&E at institutions seeking transformation. This category of award is intended to broaden the spectrum of institutions participating in ADVANCE activities, including primarily undergraduate institutions, teaching intensive colleges, community colleges, minority-serving institutions (e.g. tribal colleges, Historically Black Colleges and Universities, Hispanic Serving Institutions) and women's colleges.

- **Faculty Early Career Development (CAREER):** The FY 2008 Request provides $156.52 million for CAREER, an increase of $7.06 million over the FY 2007 Request of $149.46 million. This will result in approximately 14 more CAREER awards than in FY 2007. 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 the academic leaders of the 21st century.

- **Graduate Fellowships and Traineeships:** The FY 2008 Request provides $228.82 million, an increase of $8.93 million over the FY 2007 Request, for NSF's three flagship graduate fellowship and traineeship programs. This funding will enable NSF to support an estimated 5,375 graduate students.
  - $105.56 million for the Graduate Research Fellowship (GRF) program, an increase of $8.93 million above the FY 2007 Request, will support graduate students in all STEM fields. Funding will support an estimated 2,950 fellows.
  - $67.40 million for the Integrative Graduate Education and Research Traineeship (IGERT) program, equal to the FY 2007 Request, 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 1,510 IGERT trainees.
  - $55.86 million for the Graduate Teaching Fellowships in K-12 Education (GK-12) program, equal to the FY 2007 Request, 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 915 graduate fellows.

- **Research Experiences for Undergraduates (REU):** The FY 2008 Request for NSF's REU program totals $56.94 million, an increase of $20,000 above the FY 2007 Request of $56.92 million. The REU program supports active research participation by undergraduate students in any area of research funded by the NSF. 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. Some REU grants have been extended to the freshman and sophomore levels to enhance retention and graduation rates.

- **Research Experiences for Teachers: (RET):** The FY 2008 Request for NSF's RET program totals $9.64 million, an increase of $1.13 million above the FY 2007 Request of $8.51 million. Funding will provide pre-service and in-service K-12 teachers with discovery-based learning experiences.

PERFORMANCE INFORMATION

This chapter provides supporting information on the performance activities used in developing NSF's FY 2008 Request. The NSF Strategic Plan for FY 2006-2011 established a new overall framework for evaluating NSF's performance through the Discovery, Learning, Research Infrastructure, and Stewardship strategic goals. Two overarching objectives are associated with these goals: To Inspire and Transform and To Grow and Develop. Annual performance goals and measures have been established for the Stewardship goal. In addition, three of NSF's investment categories under its previous Strategic Plan were assessed for this budget cycle through the Program Assessment Rating Tool (PART): Centers and Capability Enhancement under the previous Ideas goal, and Infrastructure and Instrumentation under the previous Tools goal.

NSF's leadership in advancing the frontiers of science and engineering research and education is demonstrated, in part, through internal and external performance assessments. The results of our performance assessment process provide our stakeholders and the American taxpayer with vital information about the return on our investments. Performance assessment at NSF is guided by the Government Performance and Results Act (GPRA) of 1993, the Performance Assessment Rating Tool (PART), as well as the Strategic Plan.

National Science Foundation
By Strategic Outcome Goal*
(Dollars in Millions)

	FY 2006 Actuals	FY 2007 Request	FY 2008 Request	Change over FY 2007	
				Amount	Percent
Discovery	$2,942.82	$3,086.93	$3,312.96	$226.03	7.3%
Learning	878.99	898.51	938.22	39.71	4.4%
Research Infrastructure	1,508.17	1,685.24	1,813.99	128.75	7.6%
Stewardship	315.82	349.53	363.83	14.30	4.1%
Total, NSF	$5,645.79	$6,020.21	$6,429.00	$408.79	6.8%

Totals may not add due to rounding.

*New Strategic Plan Outcome Goals presented here are roughly equivalent to Ideas, People, Tools, and Organizational Excellence in the FY 2003 - 2008 Strategic Plan.

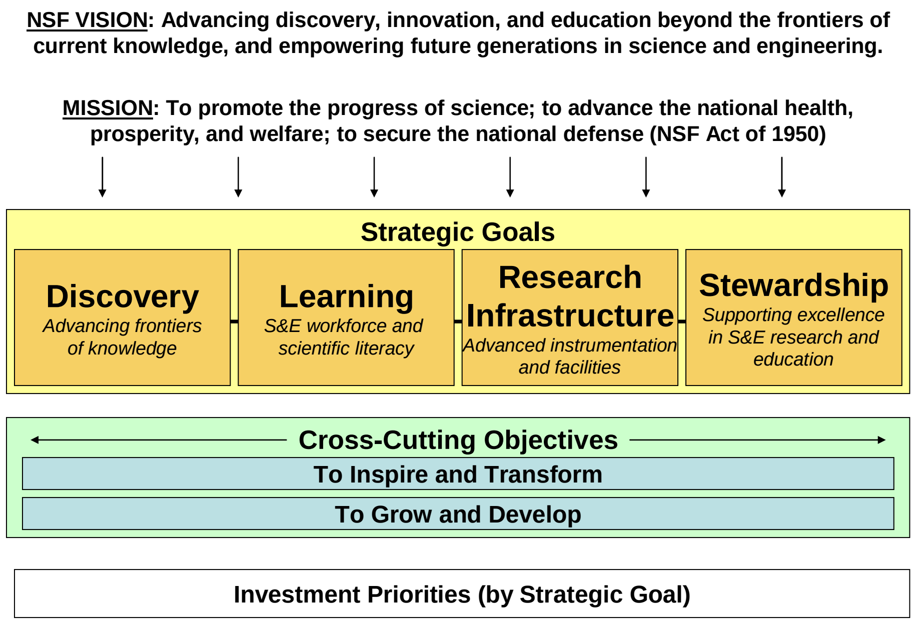
For NSF and other federal agencies with significant R&D portfolios, assessment activities are required to draw heavily upon the R&D Investment Criteria established by OMB and the Office of Science and Technology Policy. These three criteria, Relevance, Quality, and Performance are listed below and are 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.

The NSF Strategic Plan for FY 2006 – 2011 provides the basis for performance evaluation of all NSF activities. The performance framework is illustrated in the chart below.



The four interrelated goals – *Discovery*, *Learning*, *Research Infrastructure*, and *Stewardship* – establish an integrated strategy to deliver new knowledge at the frontiers, meet vital national needs, and work to achieve the NSF vision. Although these goals are similar to the previous Strategic Plan's goals of *Ideas, People, Tools,* and *Organizational Excellence*, the first three goals are aligned directly with the three strategic priorities recently established in the *National Science Board 2020 Vision for the National Science Foundation*. The fourth goal, Stewardship, was added as an internally focused goal to support excellence in science and engineering research and education through a capable and responsive organization.

The external Advisory Committee for GPRA Performance Assessment (AC/GPA) will evaluate NSF's achievement under *Discovery, Learning, and Research Infrastructure* to determine if NSF has demonstrated significant achievement. In doing so, the Committee will be guided by the two objectives: *To Inspire and Transform*, and *To Grow and Develop*. For the *Stewardship* goal, the Foundation has established annual goals to monitor progress in improving administrative and management practices.

Annual performance measures are also linked to the Foundation's program priorities and key investments and the long term investment priorities under the strategic outcome goals. Some annual performance measures are taken from NSF's PART (Program Assessment Rating Tool) evaluations that began in FY 2003. NSF was rated "Effective" (the highest rating) in all of its PART evaluations. Complete PART results are available at www.whitehouse.gov/omb/expectmore/index.html.

STRATEGIC OUTCOME GOALS

***Discovery* - Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.**

FY 2008 Annual Performance Goal for Discovery: NSF will demonstrate significant achievement for the two objectives related to the Discovery strategic outcome goal: *To Inspire and Transform* and *To Grow and Develop.*

Means and Strategies for Success: NSF's ongoing portfolio of investments and continuing priorities are outlined in this budget submission. In addition, the following long-term investment priorities, associated with the strategic goal of Discovery, have been identified for increased emphasis or additional funding during 2006-2011.

- Promote transformational, multidisciplinary research.
- Investigate the human and social dimensions of new knowledge and technology.
- Further U.S. economic competitiveness.
- Foster research that improves our ability to live sustainably on Earth.
- Advance fundamental research in computational science and engineering, and in fundamental, applied, and interdisciplinary mathematics and statistics.

Baseline/Prior Year Results: This goal is a continuation of NSF's previous goal of Ideas. FY 2001 was the first year that NSF had an annual performance goal with associated indicators for Ideas. Each fiscal year's performance indicators may differ from those of prior years, but in all cases they serve as measures of progress toward achievement of NSF's strategic outcome goal. The Foundation's external Advisory Committee for GPRA Performance Assessment (AC/GPA) determined that NSF was successful in achieving the annual performance goal associated with the Ideas strategic outcome goal in FY 2006. Find the latest AC/GPA Report at www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf06206.

Resources Required: This goal can be achieved with NSF's requested FY 2008 staff and budgetary resources.

Program Assessment Rating Tool (PART) Evaluations: Three PART evaluations were conducted based on the investment categories within NSF's previous goal of Ideas. All were rated "effective."

***Learning* – Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.**

FY 2008 Annual Performance Goal for Learning: NSF will demonstrate significant achievement for the two objectives related to the Learning strategic outcome goal: *To Inspire and Transform* and *To Grow and Develop.*

Means and Strategies for Success: NSF's ongoing portfolio of investments and continuing priorities are outlined in this budget submission. In addition, the following long-term investment priorities, associated with our strategic goal of Learning, have been identified for increased emphasis or additional funding during 2006-2011.

- Build strong foundations and foster innovation to improve K-12 teaching, learning, and evaluation in science and mathematics.
- Advance the fundamental knowledge base on learning, spanning a broad spectrum from animals and humans to machines.
- Develop methods to effectively bridge critical junctures in STEM education pathways.
- Prepare a diverse, globally engaged STEM workforce.
- Integrate research with education, and build capacity.
- Engage and inform the public in science and engineering through informal education.

Baseline/Prior Year Results: This goal is a continuation of NSF's previous goal of People. FY 2001 was the first year that NSF had an annual performance goal with associated indicators for People. Each fiscal year's performance indicators may differ from those of prior years, but in all cases they serve as measures of progress toward achievement of NSF's strategic outcome goal. The Foundation's external Advisory Committee for GPRA Performance Assessment (AC/GPA) determined that NSF was successful in achieving the annual performance goal associated with the Ideas strategic outcome goal in FY 2006. Find the latest AC/GPA Report at www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf06206.

Resources Required: This goal can be achieved with NSF's requested FY 2008 staff and budgetary resources.

Program Assessment Rating Tool (PART) Evaluations: Three PART evaluations were conducted based on the investment categories within NSF's previous goal of People. All were rated "effective."

Research Infrastructure* – *Build the Nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.

FY 2008 Annual Performance Goal for Research Infrastructure: NSF will demonstrate significant achievement for the two objectives related to the Research Infrastructure strategic outcome goal: *To Inspire and Transform* and *To Grow and Develop*.

Means and Strategies for Success: NSF's ongoing portfolio of investments and continuing priorities are outlined in this budget submission. In addition, the following long-term investment priorities, associated with our strategic goal of Research Infrastructure, have been identified for increased emphasis or additional funding during 2006-2011.

- Fill the gaps in our ability to provide enabling research infrastructure.
- Identify and support the next generation of large research facilities.
- Develop a comprehensive, integrated cyberinfrastructure to drive discovery in all fields of science and engineering.
- Strengthen the Nation's collaborative advantage by developing unique networks and innovative partnerships.

Baseline/Prior Year Results: This goal is a continuation of NSF's previous goal of Tools. FY 2001 was the first year that NSF had an annual performance goal with associated indicators for Tools. Each fiscal year's performance indicators may differ from those of prior years, but in all cases they serve as measures of progress toward achievement of NSF's strategic outcome goal. The Foundation's external Advisory Committee for GPRA Performance Assessment (AC/GPA) determined that NSF was successful in achieving the annual performance goal associated with the Tools strategic outcome goal in FY 2006. Find the latest report at www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf06206.

Resources Required: This goal can be achieved with NSF's requested FY 2008 staff and budgetary resources.

Program Assessment Rating Tool (PART) Evaluations: Four PART evaluations were conducted based on the investment categories within NSF's previous goal of Tools. All were rated "effective."

Stewardship ***- Support excellence in science and engineering research and education through a capable and responsive organization.***

FY 2008 Strategic Goal for Stewardship: The Stewardship strategic outcome goal is fundamental to NSF's leadership in implementing outstanding results-oriented management practices and establishing collaborative partnerships with the scientific and federal communities. As the Foundation transitions to a new Strategic Plan for the period 2006 - 2011, new annual performance measures have been adopted to illustrate NSF's continuing emphasis on improvement of the effectiveness and efficiency of its internal operations.

Means and Strategies for Success: Several long-term investment priorities associated with our strategic goal of Stewardship were identified in the Strategic Plan for increased emphasis or additional funding during 2006-2011. As a result, the Foundation has developed the following annual Stewardship goals:

- Time to Decision: For 70 percent of proposals, be able to inform applicants whether their proposals have been declined or recommended for funding within six months of deadline or target date or receipt date, whichever is later.
- Merit Review: Improve the transparency of our decisions and the quality of the merit review process.
- Customer Service: Improve customer service to the science, engineering, and education communities.
- Broaden Participation: Expand efforts to increase participation from underrepresented groups and diverse institutions throughout the United States in all NSF activities and programs.
- Management of Large Facilities: Ensure the effective management of the construction and operation of large facilities.
- Post-Award Monitoring: Fully implement NSF's program of post-award financial and administrative monitoring.
- E-Government: Establish an E-Government Implementation Plan.
- IT Security: Conduct a successful FISMA IT Security Program Review.

Baseline/Prior Year Results: This goal is a continuation and expansion of NSF's goal of Organizational Excellence. NSF achieved the goal in FY 2006. Evaluation of achievement included input from two groups of external experts: The Advisory Committee for GPRA Performance Assessment and the Advisory Committee for Business and Operations.

Resources Required: This goal can be achieved with NSF's requested FY 2008 staff and budgetary resources.

Program Assessment Rating Tool (PART)

NSF used the Program Assessment Rating Tool to assess three of the investment categories that existed under the previous Strategic Plan to inform the FY 2008 budget decision-making process: Capability Enhancement, Centers, and Infrastructure and Instrumentation. These programs, as well as the Foundation's other PART evaluations, were given the highest rating of "Effective." Complete PART results are available at www.whitehouse.gov/omb/expectmore/index.html.

The Capability Enhancement PART Program included several NSF programs: Centers of Research Excellence in Science and Technology (CREST), EPSCoR (Experimental Program to Stimulate Competitive Research, SBIR (Small Business Innovation Research), STTR (Small Business Technology Transfer), Industry/University Cooperative Research Centers (I/UCRC), Research Opportunity Awards, and Research in Undergraduate Institutions. Investments in these programs strengthen NSF's commitment to broadening participation from groups that are underrepresented in the science and engineering workforce; strengthening partnerships with industry, particularly small businesses; and supporting research in undergraduate institutions.

The Centers PART Program encompassed Science and Technology Centers, Engineering Research Centers, Materials Research Science and Engineering Centers, Nanoscale Science and Engineering Centers, Chemical Bonding Centers, Centers for Analysis and Synthesis, and Science of Learning Centers. The purpose of the program is to enable academic institutions along with their non-academic partner institutions to integrate research and education on scales that are extensive enough to significantly impact important science and engineering fields through large-scale, organized efforts. Research efforts at these centers stimulate collaborations across organizations, disciplines, sectors, and international boundaries. Centers address specific problems, interests, and national needs that cannot be met fully under traditional individual investigator, small group, or instrumentation awards.

The Infrastructure and Instrumentation PART Program included the Digital Library Program, the Major Research Instrumentation Program, Shared Cyberinfrastructure Tools, Science Resources Statistics, and Research Resources. Its purpose is to support the development and use of technological tools for scientific and engineering research and education. Within these programs, concepts are evolving to encompass distributed systems including software, databases, telescience capabilities, and expert systems. Rapid advances in computing power, communications bandwidth, data storage, and distributed systems allow innovative collaborative and data-intensive research styles in revolutionary ways. NSF's PART schedule is shown below.

National Science Foundation PART Assessments

Budget Year	Investment Category	Rating
FY 2009:	K-12 Education	
FY 2008:	Capability Enhancement	Effective
	Centers	Effective
	Infrastructure and Instrumentation	Effective
FY 2007:	Fundamental Science and Engineering	Effective
	Federally Funded Research and Development Centers	Effective
FY 2006:	Biocomplexity in the Environment Priority Area	Effective
	Institutions	Effective
	Collaborations	Effective
	Polar Tools, Facilities and Logistics	Effective

FY 2005:	Nanoscale Science and Engineering Priority Area	Effective
	Information Technology Research Priority Area	Effective
	Individuals	Effective
	Facilities	Effective

New PART Structure

On September 30, 2006, NSF adopted a new Strategic Plan for FY 2006 – 2011, which features four strategic outcome goals of Discovery, Learning, Research Infrastructure, and Stewardship and two overarching objectives: *To Inspire and Transform* and *To Grow and Develop*. However, the investment categories in the previous Strategic Plan, upon which the PARTs were based, were not carried over into the new Plan. Beginning in FY 2007, the Foundation will conduct PART evaluations on Research Activities, Centers, K-12 Math and Science Education, Postsecondary Education and Informal Science Education, Facilities, and Polar Facilities and Logistics. These PART evaluations fall under the first three strategic outcome goals of Discovery, Learning, and Research Infrastructure. The fourth outcome goal of Stewardship, which is to "support excellence in science and engineering research and education through a capable and responsive organization," will still not be a subject of a PART evaluation but will be monitored according to annual performance goals.

ANNUAL PERFORMANCE GOALS

The National Science Foundation's annual performance goals consist of the performance measures developed during the PART evaluation process and new annual Stewardship goals that focus on important administrative and management priorities for the Foundation. Examples of new Stewardship goals are to improve the transparency of our decisions and the quality of the merit review process, to expand efforts to increase participation from underrepresented groups and diverse institutions throughout the United States in all NSF activities, and to ensure the effective management of the construction and operation of large facilities. One important efficiency goal that has been in place for several years is the time-to-decision goal, explained below. Examples of other existing annual performance goals follow.

FY 2008 Annual Performance Goal – Time to Decision: For 70 percent of proposals, be able to inform applicants whether their proposals have been declined or recommended for funding within six months of deadline or target date, or receipt date, whichever is later.

Time-to-Decision					
	2004	**2005**	**2006**	**2007**	**2008**
Goal	70%	70%	70%	70%	70%
Result	77%	76%	78%	&	&

& = data not yet available

Several of NSF's PART programs have adopted the time-to-decision goal for their individual programs. These goals include a quality component based on a review by the Advisory Committee for GPRA Performance Assessment. That component is to maintain a credible and efficient merit review system, as evaluated by external experts. Merit review is the cornerstone of the National Science Foundation's work and is an international "gold standard" for review of science and engineering research proposals. The chart below shows results for FY 2004-2006 and targets for 2007-2008.

Time-to-Decision by PART Program										
	2004		2005		2006		2007		2008	
	Goal	Result	Goal	Result	Goal	Result	Goal	Result	Goal	Result
Individuals	70%	74%	70%	78%	70%	85%	70%	&	70%	&
Institutions	70%	83%	70%	76%	70%	74%	70%	&	70%	&
Collaborations	70%	82%	70%	82%	70%	78%	70%	&	70%	&
Capability Enhancement	n/a	n/a	n/a	n/a	70%	93%	70%	&	70%	&
Fundamental Science & Engineering	70%	83%	70%	73%	70%	76%	70%	&	70%	&
Infrastructure & Instrumentation	n/a	n/a	n/a	n/a	70%	67%	70%	&	70%	&

& = data not yet available

FY 2008 Annual Performance Goal – Graduate Fellowships and Traineeships: The number of graduate students supported through the NSF's three primary fellowship and traineeship programs is a key performance measure. The annual performance goal is to increase the 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). In FY 2008, an increase is requested for these three flagship programs, which will enable NSF to support an estimated 5,375 graduate students.

FY 2008 Annual Performance Goal – MREFC Construction: For all MREFC projects, keep negative cost and schedule variances to less than 10 percent. This goal applies to all current MREFC projects and those to be completed in FY 2008 that have a total project cost of at least $5.0 million.

Facility Construction (MREFC)					
	FY 2004	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**
Goal	90%	90%	90%	90%	90%
Result	100%	79%	73%	&	&

& = data not yet available

FY 2008 Annual Performance Goal – Facility Operations: For 90 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 $8.0 million in annual operations and maintenance support.

Facility Operating Time					
	FY 2004	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**
Goal	90%	90%	90%	90%	90%
Result	26 of 29 (89.7%) facilities met goal	100%	95%	&	&

& = data not yet available

FY 2008 Annual Performance Goal – Increase the number of users of National Center for Atmospheric Research (NCAR) data sets with unique access addresses who have downloaded data within the last 12 months.

Use of NCAR Data Sets					
	FY 2004	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**
Goal	1332	3000	4500	5000	5500
Result	2191	3990	4779	&	&

& = data not yet available

FY 2008 Performance Goal – Maintain a high percentage of observing time at the National Optical Astronomy Observatory that is awarded competitively through the NOAO allocation committee.

NOAO Observing Time					
	FY 2004	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**
Goal	baseline	95%	95%	95%	95%
Result	98.6%	96.4%	98.5%	&	&

& = data not yet available

FY 2008 Annual Performance Goal – Increase the number of distinct science/engineering/education users who make use of the TeraGrid (a distributed national infrastructure supporting computational science).

Users of the TeraGrid					
	FY 2004	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**
Goal	n/a	n/a	2500	3500	4500
Result	600	1800	3200	&	&

& = data not yet available

TECHNICAL INFORMATION

FY 2008 Appropriations Language

National Science Foundation

RESEARCH AND RELATED ACTIVITIES

For necessary expenses in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), and the Act to establish a National Medal of Science (42 U.S.C. 1880-1881); services as authorized by 5 U.S.C. 3109; maintenance and operation of aircraft and purchase of flight services for research support; acquisition of aircraft; $5,131,690,000, to remain available until September 30, 2009, of which not to exceed $510,000,000 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.

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, $750,600,000, to remain available until September 30, 2009.

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, $244,740,000, to remain available until expended.

AGENCY OPERATIONS AND AWARD MANAGEMENT

For agency operations and award management 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; $285,590,000: *Provided*, That contracts may be entered into under this heading in fiscal year 2008 for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year.

OFFICE OF INSPECTOR GENERAL

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, as amended, $12,350,000, to remain available until September 30, 2009.

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.), $4,030,000: *Provided*, That not more than $9,000 shall be available for official reception and representation expenses.

SUMMARY OF FY 2008 BUDGET BY APPROPRIATION AND ACTIVITY

(DOLLARS IN MILLIONS)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	CHANGE OVER FY 2007 Amount	Percent
RESEARCH AND RELATED ACTIVITIES					
Biological Sciences	$580.90	$607.85	$633.00	$25.15	4.1%
Computer and Information Science and Engineering	496.35	526.69	574.00	47.31	9.0%
Engineering	585.46	628.55	683.30	54.75	8.7%
Geosciences	703.95	744.85	792.00	47.15	6.3%
Mathematical and Physical Sciences	1,086.61	1,150.30	1,253.00	102.70	8.9%
Social, Behavioral and Economic Sciences	201.23	213.76	222.00	8.24	3.9%
Office of International Science and Engineering[1]	42.61	40.61	45.00	4.39	10.8%
Office of Cyberinfrastructure	127.14	182.42	200.00	17.58	9.6%
U.S. Polar Research Programs	323.88	370.58	397.38	26.80	7.2%
U.S. Antarctic Logistical Support Activities	66.66	67.52	67.52	-	0.0%
Integrative Activities[2]	233.30	231.37	263.00	31.63	13.7%
U.S. Arctic Research Commission	1.17	1.45	1.49	0.04	2.8%
Subtotal R&RA Activities	$4,449.25	$4,765.95	$5,131.69	$365.74	7.7%
Unobligated Balance Available Start of Year	-7.06				
Unobligated Balance Available End of Year	3.94				
Recoveries of Prior Year Obligations	-8.67				
EPSCoR adjustment[3]	-98.22	-100.00			
Adjustments to Prior Year Accounts	-0.04				
Unobligated Balance Expired	-				
Reductions Pursuant to P.L. 109-108, P.L. 109-148	56.04				
Subtotal R&RA	$4,395.25	$4,665.95	$5,131.69	$465.74	10.0%
Transferred from other funds	-7.73				
Appropriation Total	$4,387.52	$4,665.95	$5,131.69	$465.74	10.0%
EDUCATION AND HUMAN RESOURCES [4]					
Research on Learning in Formal and Informal Settings	215.58	215.00	222.50	7.50	3.5%
Undergraduate Education	211.86	196.80	210.22	13.42	6.8%
Graduate Education	153.07	160.57	169.50	8.93	5.6%
Human Resource Development	119.75	143.85	148.38	4.53	3.1%
Subtotal EHR Activity	$700.26	$716.22	$750.60	$34.38	4.8%
Unobligated Balance Available Start of Year	-0.40				
Unobligated Balance Available End of Year	0.13				
Recoveries of Prior Year Obligations	-1.86				
EPSCoR adjustment[3]	98.22	100.00			
Adjustments to Prior Year Accounts	-				
Unobligated Balance Expired	0.34				
Reductions Pursuant to P.L. 109-108, P.L. 109-148	10.31				
Appropriation Total	$807.00	$816.22	$750.60	-$65.62	-8.0%

Totals may not add due to rounding

[1] OISE FY 2006 Actual includes $7.73 million provided to NSF by the U.S. Department of State for an award to the U.S. Civilian Research and Development

[2] EPSCoR is included in Integrative Activities for all years shown for comparability.

[3] In FY 2006 and FY 2007, $98.22 million and $100.0 million, respectively, are being reported for EPSCoR in Integrative Activities within R&RA appropriation. The FY 2006 Actual and FY 2007 Request are therefore adjusted to reflect the structure at that time.

[4] Excludes $99.40 million in obligations in FY 2006 and an estimated $100.0 million in FY 2007 and FY 2008 receipts from H-1B Nonimmigrant Petitioner Fees.

SUMMARY OF FY 2008 BUDGET BY APPROPRIATION AND ACTIVITY

(DOLLARS IN MILLIONS)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	CHANGE OVER FY 2007 Amount	Percent
MAJOR RESEARCH EQUIPMENT & FACILITIES CONSTRUCTION	$233.81	$240.45	$244.74	$4.29	1.8%
Unobligated Balance Available Start of Year	-45.68				
Unobligated Balance Available End of Year	2.78				
Recoveries of Prior Year Obligations	-0.03				
Adjustments to Prior Year Accounts	-				
Reductions Pursuant to P.L. 109-108, P.L. 109-148	2.47				
Appropriation Total	$193.35	$240.45	$244.74	$4.29	1.8%
AGENCY OPERATIONS AND AWARD MANAGEMENT [1]	$247.06	$281.82	$285.59	$3.77	1.3%
Unobligated Balance Available Start of Year	-				
Unobligated Balance Available End of Year	-				
Adjustments to Prior Year Accounts	-				
Unobligated Balance Expired	-				
Reductions Pursuant to P.L. 109-108, P.L. 109-148	3.19				
Subtotal, AOAM	$250.25	$281.82	$285.59	$3.77	1.3%
Transferred from other funds	-0.25				
Appropriation Total	$250.00	$281.82	$285.59	$3.77	1.3%
NATIONAL SCIENCE BOARD	$3.94	$3.91	$4.03	$0.12	3.1%
Unobligated Balanced Available Start of Year	-				
Unobligated Balanced Available End of Year	-				
Recoveries of Prior Year Obligations	-				
Adjustments to Prior Year Accounts	-				
Unobligated Balance Expired	0.01				
Reductions Pursuant to P.L. 109-108, P.L. 109-148	0.05				
Appropriation Total	$4.00	$3.91	$4.03	$0.12	3.1%
OFFICE OF INSPECTOR GENERAL	$11.47	$11.86	$12.35	$0.49	4.1%
Unobligated Balanced Available Start of Year	-1.10				
Unobligated Balanced Available End of Year	1.01				
Recoveries of Prior Year Obligations	-				
Adjustments to Prior Year Accounts	-0.03				
Unobligated Balance Expired	-				
Reductions Pursuant to P.L. 109-108, P.L. 109-148	0.15				
Appropriation Total	$11.50	$11.86	$12.35	$0.49	4.1%
TOTAL, NATIONAL SCIENCE FOUNDATION	$5,653.37	$6,020.21	$6,429.00	$408.79	6.8%

Totals may not add due to rounding.

[1] The FY 2006 Actual includes a transfer of $250,000 from the Department of State for processing an award to the U.S. Civilian Research and Development Foundatio

NSF FUNDING BY PROGRAM

(Dollars in Millions)

PROGRAM	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change Over FY 2007 Amount	Change Over FY 2007 Percent
BIOLOGICAL SCIENCES					
MOLECULAR AND CELLULAR BIOSCIENCES	$108.46	$111.22	$116.37	$5.15	4.6%
INTEGRATIVE ORGANISMAL SYSTEMS	100.83	100.74	105.49	4.75	4.7%
ENVIRONMENTAL BIOLOGY	107.21	109.61	114.66	5.05	4.6%
BIOLOGICAL INFRASTRUCTURE	82.02	85.90	96.10	10.20	11.9%
Research Resources	*51.28*	*53.58*	*61.32*	*7.74*	*14.4%*
Human Resources	*30.74*	*32.32*	*34.78*	*2.46*	*7.6%*
EMERGING FRONTIERS	81.87	99.16	99.16	-	-
PLANT GENOME	100.51	101.22	101.22	-	-
Total, BIO	$580.90	$607.85	$633.00	$25.15	4.1%
COMPUTER AND INFORMATION SCIENCE AND ENGINEERING					
COMPUTING & COMMUNICATION FOUNDATIONS	$105.30	$122.82	$149.15	$26.33	21.4%
COMPUTER & NETWORK SYSTEMS	141.07	162.98	191.98	29.00	17.8%
INFORMATION & INTELLIGENT SYSTEMS	103.78	119.30	154.63	35.33	29.6%
INFORMATION TECHNOLOGY RESEARCH	146.20	121.59	78.24	-43.35	-35.7%
Total, CISE	$496.35	$526.69	$574.00	$47.31	9.0%
ENGINEERING					
CHEMICAL, BIOENGINEERING, ENVIRONMENTAL & TRANSPORT SYSTEMS	$125.09	$124.44	$144.97	$20.53	16.5%
CIVIL, MECHANICAL & MANUFACTURING INNOVATION	148.82	152.16	174.08	21.92	14.4%
ELECTRICAL, COMMMUNICATIONS & CYBER SYSTEMS	77.91	80.90	93.96	13.06	16.1%
INDUSTRIAL INNOVATION & PARTNERSHIPS	109.65	120.08	128.39	8.31	6.9%
SBIR/STTR	[99.07]	[108.88]	[116.41]	[7.53]	[6.9%]
ENGINEERING EDUCATION & CENTERS	123.99	125.97	116.90	-9.07	-7.2%
EMERGING FRONTIERS IN RESEARCH & INNOVATION		25.00	25.00	-	-
Total, ENG	$585.46	$628.55	$683.30	$54.75	8.7%

NSF FUNDING BY PROGRAM

(Dollars in Millions)

PROGRAM	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change Over FY 2007 Amount	Change Over FY 2007 Percent
GEOSCIENCES					
ATMOSPHERIC SCIENCES	$216.13	$226.85	$240.84	$13.99	6.2%
Atmospheric Sciences Research Support	*132.65*	*141.12*	*151.09*	*9.97*	*7.1%*
National Center for Atmospheric Research	*83.48*	*85.73*	*89.75*	*4.02*	*4.7%*
EARTH SCIENCES	140.35	152.30	163.30	11.00	7.2%
Earth Sciences Project Support	*105.77*	*115.90*	*126.90*	*11.00*	*9.5%*
Instrumentation and Facilities	*34.58*	*36.40*	*36.40*	-	-
INNOVATIVE & COLLABORATIVE EDUCATION AND RESEARCH	58.37	58.57	58.57	-	-
OCEAN SCIENCES	289.09	307.13	329.29	22.16	7.2%
Ocean Section	*107.89*	*114.62*	*118.82*	*4.20*	*3.7%*
Integrative Programs Section	*105.77*	*112.37*	*117.33*	*4.96*	*4.4%*
Marine Geosciences Section	*75.43*	*80.14*	*93.14*	*13.00*	*16.2%*
Total, GEO	$703.95	$744.85	$792.00	$47.15	6.3%
MATHEMATICAL AND PHYSICAL SCIENCES					
ASTRONOMICAL SCIENCES	$199.75	$215.11	$232.97	$17.86	8.3%
CHEMISTRY	180.70	191.10	210.54	19.44	10.2%
MATERIALS RESEARCH	242.59	257.45	282.59	25.14	9.8%
MATHEMATICAL SCIENCES	199.52	205.74	223.47	17.73	8.6%
PHYSICS	234.15	248.50	269.06	20.56	8.3%
MULTIDISCIPLINARY ACTIVITIES	29.90	32.40	34.37	1.97	6.1%
Total, MPS	$1,086.61	$1,150.30	$1,253.00	$102.70	8.9%
SOCIAL, BEHAVIORAL AND ECONOMIC SCIENCES					
SOCIAL AND ECONOMIC SCIENCES	$93.84	$99.92	$103.37	$3.45	3.5%
BEHAVIORAL AND COGNITIVE SCIENCES	80.60	84.13	87.63	3.50	4.2%
SCIENCE RESOURCES STATISTICS	26.79	29.71	31.00	1.29	4.3%
Total, SBE	$201.23	$213.76	$222.00	$8.24	3.9%

NSF FUNDING BY PROGRAM

(Dollars in Millions)

PROGRAM	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change Over FY 2007 Amount	Change Over FY 2007 Percent
OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING[1]	$42.61	$40.61	$45.00	$4.39	10.8%
OFFICE OF CYBERINFRASTRUCTURE	$127.14	$182.42	$200.00	$17.58	9.6%
OFFICE OF POLAR PROGRAMS					
ARCTIC SCIENCES	$74.21	$89.59	$96.27	$6.68	7.5%
ANTARCTIC SCIENCES	48.21	56.98	64.49	7.51	13.2%
ANTARCTIC INFRASTRUCTURE & LOGISTICS	203.17	228.61	240.66	12.05	5.3%
U.S. Antarctic Logistical Support Activities	[66.66]	[67.52]	[67.52]	-	-
POLAR ENVIROMENT, SAFETY & HEALTH	5.01	5.92	6.48	0.56	9.5%
USCG POLAR ICEBREAKING	59.94	57.00	57.00	-	-
Total, OPP	$390.54	$438.10	$464.90	$26.80	6.1%
INTEGRATIVE ACTIVITIES[2]	$233.30	$231.37	$263.00	$31.63	13.7%
EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR)	[98.22]	[100.00]	[107.00]	[7.00]	[7.0%]
U.S. ARCTIC RESEARCH COMMISSION	$1.17	$1.45	$1.49	$0.04	2.8%
Total, RESEARCH AND RELATED ACTIVITIES	$4,449.25	$4,765.95	$5,131.69	$365.74	7.7%
EDUCATION AND HUMAN RESOURCES					
RESEARCH ON LEARNING IN FORMAL AND INFORMAL SETTINGS	$215.58	$215.00	$222.50	$7.50	3.5%
UNDERGRADUATE EDUCATION	211.86	196.80	210.22	13.42	6.8%
Curriculum, Laboratory and Instructional Development	*87.93*	*86.50*	*93.70*	*7.20*	*8.3%*
Workforce Development	*60.77*	*64.30*	*70.52*	*6.22*	*9.7%*
Math and Science Partnership	*63.17*	*46.00*	*46.00*	-	-
GRADUATE EDUCATION	153.07	160.57	169.50	8.93	5.6%
HUMAN RESOURCE DEVELOPMENT	119.75	143.85	148.38	4.53	3.1%
Undergraduate/Graduate Student Support	*72.44*	*82.85*	*82.85*	-	-
Research & Education Infrastructure	*32.36*	*44.00*	*48.53*	*4.53*	*10.3%*
Opportunities for Women and Persons with Disabilities	*14.95*	*17.00*	*17.00*	-	-
Total, EHR[3]	$700.26	$716.22	$750.60	$34.38	4.8%

[1] OISE FY 2006 Actual includes $7.73 million provided to NSF by the U.S. Department of State for an award to the U.S. Civilian Research and Development Foundation.

[2] In FY 2007 EPSCoR was transferred from the EHR activity to Integrative Activities and is shown here for all years for comparability.

[3] Excludes $99.40 million in obligations in FY 2006 and an estimated $100.0 million in FY 2007 and FY 2008 receipts from H-1B Nonimmigrant Petitioner Fees.

NSF FUNDING BY PROGRAM

(Dollars in Millions)

PROGRAM	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change Over FY 2007 Amount	Change Over FY 2007 Percent
MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION	$233.81	$240.45	$244.74	$4.29	1.8%
AGENCY OPERATIONS AND AWARD MANAGEMENT[1]	$247.06	$281.82	$285.59	$3.77	1.3%
NATIONAL SCIENCE BOARD	$3.94	$3.91	$4.03	$0.12	3.1%
OFFICE OF INSPECTOR GENERAL	$11.47	$11.86	$12.35	$0.49	4.1%
NATIONAL SCIENCE FOUNDATION	$5,645.79	$6,020.21	$6,429.00	$408.79	6.8%

Totals may not add due to rounding.

[1] The FY 2006 Actual inlcudes a transfer of $250K 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 2006 Actual	FY 2007 Request	FY 2008 Request
11.1	Full-time permanent	$115	$125	$135
11.3	Other than fulltime permanent	11	12	12
11.5	Other personnel compensation	7	7	7
11.8	Special personal service payment	1	2	2
	Total personnel compensation	134	146	156
12.1	Civilian personnel benefits	30	35	37
21.0	Travel and transportation of persons	20	21	21
23.1	Rental payments to GSA	22	24	26
23.3	Communications, utilities, and miscellaneous charges	1	2	2
25.1	Advisory and assistance services	82	77	76
25.2	Other services	12	13	13
25.3	Purchases of goods and services from Government accounts	15	16	16
25.4	Operation and maintenance of facilities	292	292	292
25.5	Research and development contracts	29	23	23
2.56	Medical Care	1	1	1
25.7	Operation and maintenance of equipment	30	37	28
26.0	Supplies and materials	4	3	2
31.0	Equipment	5	11	12
41.0	Grants, subsidies, and contributions	4,969	5,319	5,724
	Total, Direct obligations [1]	$5,646	$6,020	$6,429

Totals may not add due to rounding.

[1]Excludes obligations for the Donations, H-1B Nonimmigrant Petitioners, and reimbursable 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 2006 Actual
DEFENSE	
Air Force	$11.9
Army	$7.7
Other DOD (DARPA, NSA & Intelligence Agency)	$13.2
Navy	$1.0
Subtotal, DOD	$33.8
Justice	$1.0
CIA	$5.0
Commerce (Including NOAA)	$5.6
Education	$1.2
Energy	$8.8
Labor	$1.0
Agriculture	$1.3
Health & Human Services	$24.7
Homeland Security	$1.9
NASA	$8.5
National Archives	$1.8
OTHER (less than $500,000)	$1.4
TOTAL REIMBURSEMENTS	**$96.0**

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 2006 the largest portion of NSF's reimbursable activity came from joint activities with the Department of Defense (35.2 percent), the Department of Health and Human Services (25.7 percent), the Department of Energy (9.2 percent), and National Aeronautics and Space Administration (8.9 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 of Permanent Appointments

Statutory Pay Systems	FY 2006 Actual Appointments
ES	78
AD	325
GS/GM-15	73
GS/GM-14	106
GS/GM-13	113
GS-12	92
GS-11	63
GS-10	9
GS-9	74
GS-8	54
GS-7	103
GS-6	5
GS-5	3
GS-4	-
Subtotal, GS/GM	695
Total, Permanent Appointments	1,098
Average Salary	$99,667

All data are for permanent appointments.

EXPLANATION OF CARRYOVER FOR FY 2007 BY ACCOUNT

The National Science Foundation's total unobligated balance of $106.01 million from the FY 2006 Appropriation consists of amounts described below.

- Within the **Research and Related Activities (R&RA)** appropriation, a total of $3.90 million was carried forward into FY 2007. This includes $2.06 million in Integrative Activities for the Science of Learning Centers (SLCs) and $311,512 for the Science and Technology Centers (STCs). The Directorate for Engineering carried forward $882,287 within the Small Business Innovation Research (SBIR) program and $24,776 within the Small Business Technology Transfer (STTR) program. The Office of Polar Programs carried forward $141,652 for Antarctic Infrastructure and Logistics Support. The remaining amounts are from several awards in various programs that were not ready for obligation in FY 2006.

- Within the **Education and Human Resources (EHR)** appropriation, a total of $127,903 was carried forward into FY 2007 including $110,000 for funding of the Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring Program (PAESMEM). The PAESMEM proposal recommendations are currently awaiting OSTP (White House) approval.

- Within the **Major Research Equipment and Facilities Construction (MREFC)** appropriation, a total of $2.78 million was carried forward into FY 2007 including $2.61 for EarthScope. The Office of Polar Programs carried forward $138,209 for the South Pole Station Modernization project and the South Pole Safety and Health project.

- Within the **Office of Inspector General (OIG)** appropriation, a total of $1.01 million was carried forward into FY 2007 to cover priority audits that are contracted out; fund contracts for financial analysis and other technical support for OIG investigations; provide contract support for information technology and other administrative needs of the office; and fund personnel compensation costs.

- Within the **H-1B Nonimmigrant Petitioner** account, $98.19 million was carried forward into FY 2007 since the fourth quarter receipts came in very late during FY 2006. NSF is planning to use these funds to make S-STEM and ITEST awards.

Distribution of FY 2006 Carryover into FY 2007

(Dollars in Millions)

	FY 2006 Carryover from FY 2005	FY 2007 Carryover from FY 2006
Research and Related Activities	7.06	3.90
Education and Human Resources	0.40	0.13
Major Research Equipment and Facilities Construction	45.68	2.78
Agency Operations and Award Management	-	-
National Science Board	-	-
Office of Inspector General	1.09	1.01
Subtotal	**54.23**	**7.82**
H-1B Nonimmigrant Petitioner Account	89.58	98.19
Total	**$143.81**	**$106.01**

Totals may not add due to rounding.

FULL BUDGETARY COSTING

The tables below show two methods for allocating the full budgetary cost of the NSF FY 2008 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: Discovery, Learning, and Research Infrastructure. Stewardship, 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 appropriations, Major Research Equipment and Facilities Construction (MREFC), Agency Operations and Award Management (AOAM), the National Science Board (NSB), and the Office of Inspector General (OIG) 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 AOAM, NSB, and OIG appropriations accounts are defined as Stewardship and are allocated to directorates. More than half of the AOAM account can be precisely associated with an individual directorate. These direct AOAM 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 AOAM 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, OIG, and ARC are allocated. These indirect AOAM budget items are allocated to a particular directorate based on its proportion of the total FY 2008 Request. The FY 2008 NSB, OIG, and ARC budgetary costs are assigned using the same methodology as the Indirect AOAM costs total. (Table 1)

Allocations by Strategic Outcome Goal

The full budgetary costing by Discovery, Learning, and Research Infrastructure was derived by using the same methodology as stated above, except the Direct AOAM budget items, Indirect AOAM budget items, and total NSB, and OIG funding were assigned using the strategic goal percentages for each directorate. (Table 2)

FY 2008 FULL BUDGETARY COSTING

Table 1: Allocation of Major Research Equipment and Facilities Construction (MREFC), Agency Operations and Award Management (AOAM), National Science Board (NSB), and the Office of Inspector General (OIG)

(Dollars in Thousands)

FY 2008 Congressional Request	**BIO**	**CISE**	**ENG**	**GEO**	**MPS**	**SBE**	**OCI**	**OISE**	**OPP**	**IA[1]**	**USARC**	**SUBTOTAL**	**EHR**	**TOTAL**
R&RA & EHR	**$633,000**	**$574,000**	**$683,300**	**$792,000**	**$1,253,000**	**$222,000**	**$200,000**	**$45,000**	**$464,900**	**$263,000**	**$1,490**	**$5,131,690**	**$750,600**	**$5,882,290**
MREFC														
AdvLIGO					32,750							**$32,750**		**$32,750**
ALMA Construction					102,070							**$102,070**		**$102,070**
ARRV				42,000								**$42,000**		**$42,000**
EarthScope												**-**		**-**
HIAPER												**-**		**-**
IceCube Neutrino Observatory									22,380			**$22,380**		**$22,380**
NEES												**-**		**-**
NEON	8,000											**$8,000**		**$8,000**
OOI				30,990								**$30,990**		**$30,990**
RSVP												**-**		**-**
Scientific Ocean Drilling												**-**		**-**
South Pole Station Modernization									6,550			**$6,550**		**$6,550**
Terascale Computing Systems												**-**		**-**
MREFC Subtotals	**$8,000**	**-**	**-**	**$72,990**	**$134,820**	**-**	**-**	**-**	**$28,930**	**-**	**-**	**$244,740**	**-**	**$244,740**
Total FY 2008 Request by Activity including MREFC	**$641,000**	**$574,000**	**$683,300**	**$864,990**	**$1,387,820**	**$222,000**	**$200,000**	**$45,000**	**$493,830**	**$263,000**	**$1,490**	**$5,376,430**	**$750,600**	**$6,127,030**
STEWARDSHIP														
Direct AOAM														
Space Rental	3,474	1,887	3,608	3,310	3,806	3,244	265	1,258	1,357			$22,209	$4,071	$26,280
PC&B	24,106	13,086	25,025	22,959	26,402	22,499	1,837	8,724	9,413			$154,051	$28,239	$182,290
Distributed AOAM	1,540	836	1,598	1,466	1,687	1,437	117	557	601			$9,839	$1,804	$11,643
Direct AOAM Subtotals	**$29,120**	**$15,809**	**$30,231**	**$27,735**	**$31,895**	**$27,180**	**$2,219**	**$10,539**	**$11,371**			**$186,099**	**$34,114**	**$220,213**
Indirect AOAM Cost Allocation	8,645	4,693	8,975	8,235	9,468	8,069	659	3,129	3,376			$55,249	$10,128	$65,377
Direct & Indirect AOAM Subtotals	**$37,765**	**$20,502**	**$39,206**	**$35,970**	**$41,363**	**$35,249**	**$2,878**	**$13,668**	**$14,747**			**$241,348**	**$44,242**	**$285,590**
NSB Allocation	**$533**	**$289**	**$553**	**$508**	**$583**	**$497**	**$41**	**$193**	**$208**			**$3,405**	**$624**	**$4,030**
OIG Allocation	**$1,633**	**$887**	**$1,696**	**$1,555**	**$1,789**	**$1,524**	**$124**	**$591**	**$638**			**$10,437**	**$1,913**	**$12,350**
NSF TOTAL	**$680,931**	**$595,678**	**$724,755**	**$903,023**	**$1,431,555**	**$259,270**	**$203,043**	**$59,452**	**$509,423**	**$263,000**	**$1,490**	**$5,631,620**	**$797,379**	**$6,429,000**

FY 2008 FULL BUDGETARY COSTING

Table 2: Allocation by Discovery, Learning, and Research Infrastructure

(Dollars in Thousands)

Total Directorate FY 2008	**BIO**	**CISE**	**ENG**	**GEO**	**MPS**	**SBE**	**OCI**	**OISE**	**OPP**	**IA**	**USARC**	**R&RA**	**EHR**	**TOTAL**
Discovery	480,169	504,911	633,549	434,279	895,935	194,084	15,129	41,888	110,354	134,528	1,490	3,446,316	76,611	**3,522,928**
Learning	50,335	49,669	57,299	33,066	67,497	11,015	4,103	17,564	5,586	9,217		305,351	703,565	**1,008,916**
Research Infrastructure	150,427	41,098	33,907	435,678	468,123	54,171	183,811		393,483	119,255		1,879,953	17,203	**1,897,156**
FULL BUDGETARY COST	**$680,931**	**$595,678**	**$724,755**	**$903,023**	**$1,431,555**	**$259,270**	**$203,043**	**$59,452**	**$509,423**	**$263,000**	**$1,490**	**$5,631,620**	**$797,379**	**$6,429,000**

Totals may not add due to rounding.

[1]The FY 2008 Request for R&RA includes $107.0 million for EPSCoR. Prior to FY 2008, EPSCoR was funded through the Education and Human Resources appropriation.

NATIONAL SCIENCE FOUNDATION

Research and Development Special Analysis

	FY 2006 Actual	FY 2007 Request	FY 2008 Estimate
Support of R&D		(Dollars in Millions)	
Conduct of Research and Development			
Basic Research...	$3,504.01	$3,672.20	$3,977.42
Applied Research..	286.58	378.84	380.30
Subtotal, Conduct of R&D..	3,790.59	4,051.03	4,357.72
R&D Facilities			
Land, Building and Fixed Equipment...	23.16	22.24	23.20
Major Equipment..	425.76	449.26	474.66
Subtotal, R&D Facilities & Major Equipment.......................	448.92	471.49	497.87
Total, Support of R&D...	4,239.50	4,522.53	4,855.59
Non-Investment Activities..	623.61	677.03	728.53
Education and Training...	782.68	820.65	844.89
TOTAL	$5,645.79	$6,020.21	$6,429.00

Totals may not add due to rounding.

RESEARCH AND RELATED ACTIVITIES

Research and Development Special Analysis

	FY 2006 Actual	FY 2007 Request	FY 2008 Estimate
Support of R&D		(Dollars in Millions)	
Conduct of Research and Development			
Basic Research	$3,441.51	$3,631.16	$3,910.42
Applied Research	284.34	367.91	377.90
Subtotal, Conduct of R&D	3,725.85	3,999.07	4,288.32
R&D Facilities			
Land, Building and Fixed Equipment	23.11	22.24	23.15
Major Equipment	191.95	208.65	229.92
Subtotal, R&D Facilities & Major Equipment	215.06	230.88	253.08
Total, Support of R&D	3,940.91	4,229.95	4,541.40
Non-Investment Activities	334.26	360.42	397.56
Education and Training	174.09	175.58	192.74
TOTAL	$4,449.26	$4,765.95	$5,131.69

Totals may not add due to rounding.

Includes funding for EPSCoR for all years shown for comparability. EPSCoR has been transferred from Education and Human Resources to R&RA.

EDUCATION AND HUMAN RESOURCES

Research and Development Special Analysis

	FY 2006 Actual	FY 2007 Request	FY 2008 Estimate
Support of R&D		(Dollars in Millions)	
Conduct of Research and Development			
Basic Research	$62.50	$41.04	$67.00
Applied Research	2.23	10.93	2.40
Subtotal, Conduct of R&D	64.73	$51.97	$69.40
R&D Facilities			
Land, Building and Fixed Equipment	0.05	-	0.05
Major Equipment	0.00	0.16	-
Subtotal, R&D Facilities & Major Equipment	0.05	0.16	0.05
Total, Support of R&D	64.78	52.13	69.45
Non-Investment Activities	26.88	19.03	29.00
Education and Training	608.59	645.07	652.15
TOTAL	$700.26	$716.22	$750.60

Totals may not add due to rounding.
Excludes funding for EPSCoR for all years shown for comparability. EPSCoR has been transferred from Education and Human Resources to R&RA.

MAJOR RESEARCH EQUIPMENT FACILITIES CONSTRUCTION

Research and Development Special Analysis

	FY 2006 Actual	FY 2007 Request	FY 2008 Estimate
Support of R&D		(Dollars in Millions)	
Conduct of Research and Development			
Basic Research	-	-	-
Applied Research	-	-	-
Subtotal, Conduct of R&D	-	-	-
R&D Facilities			
Land, Building and Fixed Equipment	-	-	-
Major Equipment	$233.81	$240.45	$244.74
Subtotal, R&D Facilities & Major Equipment	233.81	240.45	244.74
Total, Support of R&D	233.81	240.45	244.74
Non-Investment Activities	-	-	-
Education and Training	-	-	-
TOTAL	$233.81	$240.45	$244.74

Totals may not add due to rounding.

AGENCY OPERATIONS AND AWARD MANAGEMENT

Research and Development Special Analysis

	FY 2006 Actual	FY 2007 Request	FY 2008 Estimate
Support of R&D		(Dollars in Millions)	
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	$247.06	$281.82	$285.59
Education and Training	-	-	-
TOTAL	$247.06	$281.82	$285.59

Totals may not add due to rounding.

NATIONAL SCIENCE BOARD

Research and Development Special Analysis

	FY 2006 Actual	FY 2007 Request	FY 2008 Estimate
Support of R&D		(Dollars in Millions)	
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	$3.94	$3.91	$4.03
Education and Training	-	-	-
TOTAL	$3.94	$3.91	$4.03

Totals may not add due to rounding.

OFFICE OF INSPECTOR GENERAL

Research and Development Special Analysis

	FY 2006 Actual	FY 2007 Request	FY 2008 Estimate
Support of R&D		(Dollars in Millions)	
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	$11.47	$11.86	$12.35
Education and Training	-	-	-
TOTAL	$11.47	$11.86	$12.35

Totals may not add due to rounding.