OVERVIEW

FY 2009 BUDGET REQUEST TO CONGRESS

Budget Request

The National Science Foundation proposes a FY 2009 investment of $6.85 billion to advance the frontiers of research and education in science and engineering. The Budget Request includes an increase of $822 million (14 percent) over the FY 2008 level. These NSF investments in new knowledge and talent development are vital to advance the frontiers of discovery and to ensure that America remains a global leader in science and technology.

The Administration and Congress have conveyed their clear determination to build on America's history of success in leading-edge discovery and innovation through increased federal investments in research and education as evidenced by the President's American Competitiveness Initiative (ACI) and the America COMPETES Act of 2007.

Developments worldwide are driving a new innovation imperative. Knowledge-intensive industries, both in services and manufacturing, are reshaping the global economy. As was noted in *Science and Engineering Indicators 2008*, high-technology manufacturing worldwide has increased its share of total manufacturing output by 50 percent over the past 20 years. Similarly, knowledge-intensive services (which include business, communication, and financial services) have grown roughly 40 percent faster than other services since the mid 1990s. [1]

NSF Funding by Account
(Dollars in Millions)

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Request	Change over FY 2008 Estimate Amount	Change over FY 2008 Estimate Percent
Research and Related Activities[1/]	$4,758.44	$4,821.47	$5,593.99	$772.52	16.0%
Education and Human Resources	695.65	725.60	790.41	64.81	8.9%
Major Research Equipment and Facilities Construction	166.21	220.74	147.51	-73.23	-33.2%
Agency Operations and Award Management	248.49	281.79	305.06	23.27	8.3%
National Science Board	3.65	3.97	4.03	0.06	1.5%
Office of Inspector General	11.92	11.43	13.10	1.67	14.6%
Rescission required under P.L. 110-161[2/]	-	-33.00	-	33.00	-100.0%
Total, NSF	$5,884.37	$6,032.00	$6,854.10	$822.10	13.6%

Totals may not add due to rounding.

[1/] Funding for EPSCoR was transferred to the Research and Related Activities appropriation in FY 2008. It was previously funded within the Education and Human Resources appropriation. EPSCoR is included here in Research and Related Activities for all years for comparability.

[2/] P.L. 110-161 requires the rescission of $33.0 million from prior year unobligated balances.

[1] National Science Board. 2008. *Science and Engineering Indicators 2008*. Two volumes. Arlington, VA: National Science Foundation (volume 1, NSB 08-01; volume 2, NSB 08-01A). P. O-9. www.nsf.gov/statistics/indicators/

Continued excellence in fundamental research and education is important to sustain innovation and sharpen the Nation's competitive edge. This request upholds the commitment outlined in the ACI to double investments in three ACI agencies (NSF, the Department of Energy's Office of Science, and the Department of Commerce's National Institute of Standards and Technology) over 10 years.

NSF's task is to keep scientists and engineers focused on the furthest frontier, to recognize and nurture emerging fields, to prepare the next generation of scientific talent and leaders, to provide world-class facilities to advance research, and to ensure that all Americans gain an understanding of what science and technology have to offer. The Nation's ability to innovate and compete, its strength and versatility, depend in part on continued success in achieving these goals.

NSF has identified strategies for FY 2009 to address these challenges. The NSF portfolio aims to maintain powerful momentum across all fields of science and engineering, support potentially transformative research, build a world-class science and engineering workforce, and perform effectively and responsibly, with the highest standards of accountability.

Why Frontier Research Matters

Globalization has amplified the worldwide competition for ideas, for science and engineering talent, and for leadership in turning new knowledge into real world applications. For the last half century, the U.S. has held the commanding position in all three areas. Now, other nations are implementing new policies and stepping up investments in research and training new talent. These global initiatives pose new challenges for America's innovation enterprise.

The current pace of discovery is so rapid that identifying potentially transformative ideas and concepts is essential if our aim is to remain at the forefront of scientific research and technological innovation. The Nation's innovation system, key to economic growth and increasing productivity, thrives on the continual stream of fresh ideas that fundamental research provides, and performs at its best when diverse talent is engaged and poised to generate the sophisticated solutions necessary to meet the complex and challenging questions of our times.

America has always been a valued partner in the global arena. The international character of today's science and engineering puts a premium on our continued leadership in building collaborations, contributing to the world's knowledge and crafting solutions to global problems, as well as learning from discoveries made elsewhere. These changing global circumstances demand that we take steps to demonstrate our continued leadership.

Although U.S. expenditures for R&D (estimated at a record $340 billion in 2006) remain the highest of any nation, new challenges are on the horizon.

U.S. exports of high-technology products have eroded, raising concerns about the Nation's decades-long comparative advantage in these products. The U.S. trade balance in high-technology products shifted from surplus to deficit beginning in 2002. Rapidly increasing exports of information and communications products, particularly from China and Malaysia, account for this deficit.[2]

[2] Indicators 2008, Pp. O-10, O-19.

NSF plays an important role in addressing these challenges. Working at the leading-edge of the U.S. science and engineering enterprise, NSF provides nearly half of the federal investment in non-medical basic research at academic institutions and supports science and mathematics education at all levels.

Research that Benefits the Nation

NSF investments in research and education have returned exceptional dividends to the American people. At the same time, new opportunities to make progress in meeting pressing national needs in energy, health, security, and environment, as well as to resolve longstanding dilemmas of global scope are now more plentiful than ever before. Just this past year, researchers funded by NSF reported significant results and launched new initiatives that will keep benefits flowing to the American people and the world. Examples include:

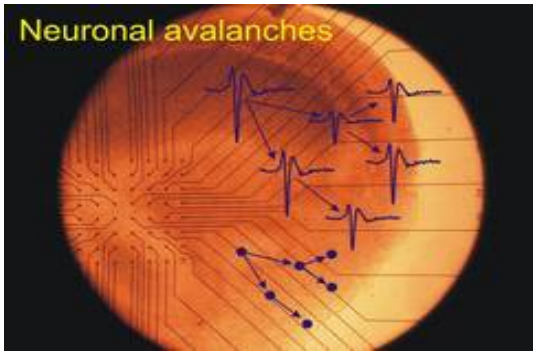
► **Wireless Power Transfer:** Researchers from the Massachusetts Institute of Technology have experimentally demonstrated an important step for the wireless transfer of power that could be used for everyday cordless devices, with the potential to revolutionize the wireless industry and eliminate the need for batteries. To produce "witricity," the researchers coupled two electromagnetic resonators, creating a highly efficient power transfer. Their design consists of two self-resonant copper coils, a sending unit, and a receiving unit. The sending unit is attached to the power source and surrounds itself with a non-radiative magnetic field. The receiving unit resonates with the field, producing a strong connection between the two units. The team crafted the strongly coupled system through this interaction, which functioned even when the two objects were separated by a large distance.

Researchers demonstrated that power levels high enough to run a laptop can be transferred over the distance of a room even with objects obstructing the sending and receiving units. *Credit: © 2007 Jupiter Images Corporation.*

Credit: Jupiter Images

► **An Integrated River Science:** Investigators are breaking new ground in quantifying how vegetation interacts with flow rates and river channel configuration during flood events. By observing, quantifying and modeling how woody debris reshapes river channels, the researchers gained guidance for a river restoration strategy that balances the benefits of restoration to the aquatic system with the benefits of reducing flood potential. These studies by an NSF-supported team from the Massachusetts Institute of Technology, Colorado State University, and Stanford University give engineers, ecologists, and water resource managers powerful tools for mitigating environmental degradation and coping with extreme floods in river systems around the world.

► **Modeling Brain Activity:** How does the brain recognize a face, or remember the route to go home? These operations are performed not by single brain cells but by networks of neurons. Researchers at Indiana University demonstrated that activity could travel through neural networks in the form of cascades, or "neuronal avalanches." When plotted on a graph these avalanches form a straight line, indicating a "power law" function. Many complex systems, including earthquakes, forest fires, nuclear chain reactions, and avalanches in sand piles have been found to obey power laws. Since simulations suggest that neuronal avalanches can simultaneously optimize information transmission and information storage, this new knowledge could lead to novel design principles for artificial neural networks and may eventually suggest approaches to improving information processing in human brains.



This shows a brain segment on top of a microelectrode array. Superimposed in the upper right are voltage signals produced by activity in groups of brain cells. These signals are connected by arrows to represent a neuronal avalanche. Neuronal avalanches can also be modeled as chain reactions, similar to those seen in nuclear fission. This is symbolized by the circles connected with arrows in the lower right. *Credit: Dr. John M. Beggs, Indiana University, Bloomington.*

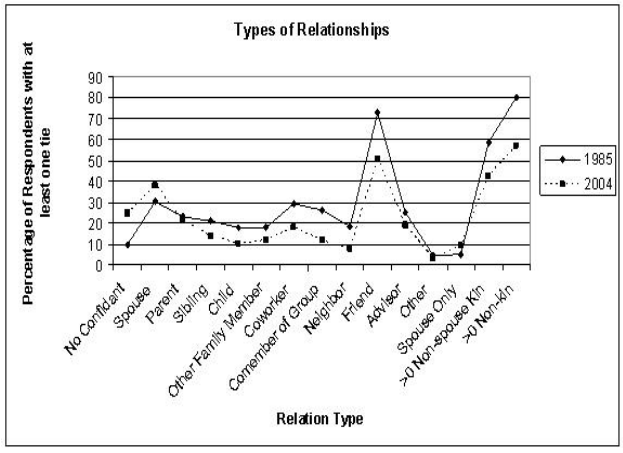
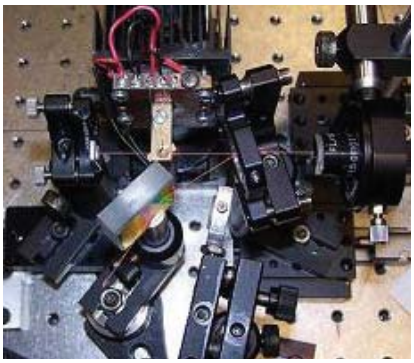


Figure shows the decrease in percentage of respondents with close social tie, by relation type, from 1985 to 2004. *Credit: Lynn Smith-Lovin, Duke University.*

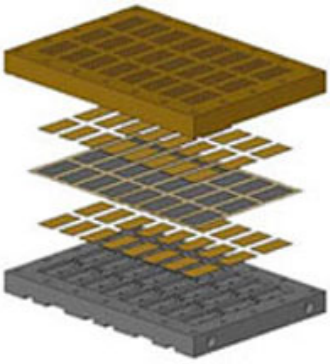
► **Social Networks in the U.S. are Shrinking:** Americans' circles of confidants have shrunk dramatically in the past two decades. The percentage of people who say they have no one with whom to discuss important matters has tripled, according to an NSF-funded study by sociologists at Duke University and the University of Arizona. This change could signal problems for our society. A close network of connections to other people creates a safety net for individuals in times of personal trouble. Having at least one connection can affect both physical and mental health. These ties are important for the community too because they often lead to civic engagement and local political action. The survey found that the number of both family and non-family confidants dropped, with the loss greatest in non-family connections.

► **Infrared Laser System: Increased Screening Sensitivity:** Researchers at the University of Alabama at Birmingham have developed a powerful system combining three types of lasers that could detect a wide range of substances in complex mixtures, including detecting trace gases at the parts per trillion level. Designed to detect and identify many types of organic molecules, the system combines high power, low noise, and coverage of the infrared spectrum that matches a large library of molecular energies. This "optical nose," developed with an NSF Major Research Instrumentation grant, could detect the presence of oil for drilling, pollutants in the atmosphere, harmful chemical or biological substances, or signs of the early stages of diseases.



The heart of the Optical Nose is a single-frequency, high-power, widely tunable Cr^{2+}:ZnSe laser. *Credit: Sergey B. Mirov, University of Alabama at Birmingham.*

► **From Discovery to Success: Polymer Membrane for Fuel Cells:** Giner, Inc. of Newton, Mass., and its subsidiary, Giner Electrochemical Systems, LLC, recipient of four NSF Small Business Innovation Research awards since 1999, were awarded a patent on a process to modify specialized polymer membranes to create compact membrane electrode structures for segmented fuel cells with higher voltages than single cells. The improvements may enable applications in electrolyzers (which convert water into hydrogen and oxygen gas), the detection and treatment of waterborne toxins, miniature sensors, industrial electro-synthesis, and other technologies that employ polymer membranes. A second patent is pending on the material itself. NSF has also provided grants to Giner for lightweight bipolar plates for fuel cells and a continuous monitor for total sulfur in natural gas.



A diagram of an array of Giner's modified polymer membrane fuel cells. *Credit: Robert MacDonald, Giner, Inc.*

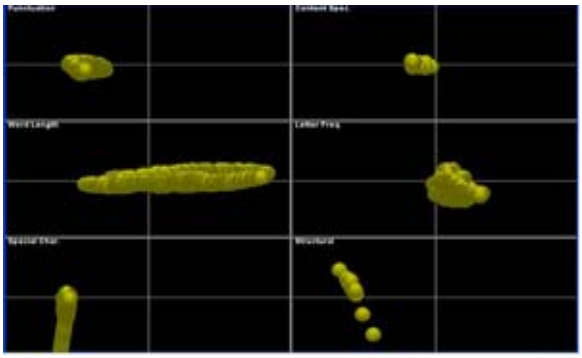
IGERT trainee Brian Schulkin shows his invention, the Mini-Z. *Credit: Rensselaer/Kris Qua.*

► **Young Inventor's Research Transforms the Marketplace:** Brian Schulkin, a participant in the NSF-funded Integrative Graduate Education and Research Traineeship program at Rensselaer Polytechnic Institute, won the first-ever Lemelson-Rensselaer $30,000 student prize. Schulkin invented an ultralight, hand-held terahertz spectrometer that has applications in medical, aerospace, security, and other fields. Terahertz rays, or "t-rays" are based on the part of the electromagnetic spectrum that is defined by frequencies from 0.1 to 10 terahertz – just between infrared light and microwave radiation. Though they can pass through clothing, wood, plastic, and other materials, t-rays are not harmful to health in the way that x-rays are. Until now, a major challenge has been the size and weight of t-ray devices. Schulkin successfully developed a system approximately the size of a laptop computer, dubbed the mini-Z. The mini-Z has already been used to detect cracks in space shuttle foam, image tumors in breast tissue, and spot counterfeit watermarks on paper currency.

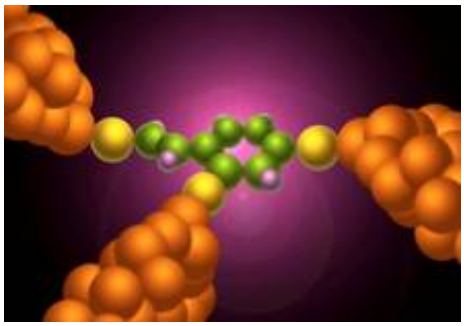
► **World's Smallest Radio:** Harnessing the unique electrical and mechanical properties of carbon nanotubes, researchers have crafted a working radio from a single nanotube that is 10,000 times thinner than the width of a single human hair. Fixed to an electrode mounted near a counter electrode, the tube successfully performed the four critical roles of a radio – antenna, tunable filter, amplifier and demodulator – to tune-in a radio signal generated in the room and play it back through an attached speaker. Tunable across a bandwidth widely used for commercial radio, the tiny device could have applications far beyond novelty, from a single receiver in a living cell to a vast array embedded in an airplane wing. The new device was developed at NSF's Center of Integrated Nanomechanical Systems at the University of California at Berkeley and the Lawrence Berkeley National Laboratory.

This transmission electron microscope image (with digital illustration of radio "waves") shows a single carbon nanotube protruding from an electrode. *Credit: Zettl Research Group, University of California at Berkeley and the Lawrence Berkeley National Laboratory.*

► **Research Helps Fight the (Cyber) War on Terror:** The speed, ubiquity, and potential anonymity of Internet media – email, Web sites, and Internet forums – make them ideal communication channels for militant groups and terrorist organizations. Analyzing content has become increasingly important to the intelligence agencies that monitor these groups. Funded by NSF, researchers at the Artificial Intelligence Lab at the University of Arizona have developed the "Dark Web" project to systematically collect and analyze terrorist-generated content online using advanced analysis techniques. The Dark Web collection, which contains more than 2,000 international terrorist sites and 50 million documents, has become a major research testbed for understanding propaganda, ideology, and operations of terrorist groups.



Writeprint visualization of an extremist forum author. Six unique online writing features are shown (from top to bottom, left-to-right): punctuation, word length, special character, content feature, letter frequency, and structural feature. Each dot represents a text segment in the author's online messages. Like a fingerprint, every author has a distinct "writeprint." *Credit: © Arizona Board of Regents for The University of AZ. Artificial Intelligence Lab, Dr. Hsinchun Chen, Director.*



This conception visualizes how molecular transistors might work. A sulfonated vinyl benzene molecule lies at the core. The colors code the carbon (green), hydrogen (purple), sulfur (yellow), and gold (gold) atoms. *Credit: Charles A. Stafford, University of Arizona.*

► **From Molecules to Computers: Theory Finds a Switch:** Theoretical physicists at the University of Arizona have developed a fundamental theory of how a current of electrons flows through a single organic molecule. Based on fundamental physical principles, the theory also predicts a way to control a current through the molecule. The results could be used to design an electric switch that operates on fundamentally different principles from modern transistors at the heart of virtually all electronic technology. Because these switches are the size of a single molecule, they provide a way to overcome the fundamental problems of power dissipation and environmental sensitivity that limit the continued rate of device miniaturization.

► **Cyber Corps Partnerships at Mississippi State:** Since 2002, Mississippi State University (MSU) has accomplished a 100 percent placement rate for its NSF Scholarship for Service (SFS) students. With support from an NSF SFS capacity building grant, MSU has partnered with Jackson State University (JSU), an historically black college or university, to assist them in developing an information assurance program. Through this assistance, JSU now has its own computer security class and computer forensics class patterned after those taught at MSU. In addition, JSU partners with MSU in the production of SFS students and has placed four students in government service from this partnership. Also with SFS capacity building support, MSU brought

Washington DC high school students participating in a cyber security training workshop at Mississippi State University. *Credit: Rayford Vaughn.*

minority high school students from Washington, D.C. to MSU for training in computer security. Another SFS project supported the enhancement of MSU's digital forensics laboratory, which led to securing a major grant from the Department of Justice to train more than 1,200 law enforcement officers in cyber-crime techniques.

Budget Highlights

Cross-Foundation Investments. The FY 2009 Request includes four major cross-foundation investments that aim to have a transformative impact across science and engineering, especially in such areas of national priority as manufacturing, computing, energy, cybersecurity, sensors, and materials.

- **Cyber-enabled Discovery and Innovation (CDI),** initiated in FY 2008, increases to $100.0 million (from $47.9 million) in FY 2009 to advance science and engineering along fundamentally new pathways opened by computational capabilities. FY 2009 investments include three specific foci: From Data to Knowledge, Understanding System Complexity, and Virtual Organizations.
- **Science and Engineering Beyond Moore's Law (SEBML)** aims to position the U.S. at the forefront of communications and computation capability beyond the physical and conceptual limitations of current systems. This $20.0 million, NSF-wide effort addresses the reality that in 10 to 20 years, current silicon technology will reach the limits of Moore's Law – the empirical observation that computing power doubles roughly every 18 months. Activities in FY 2009 will encourage transformational activities as well as creating partnering opportunities with the private sector and national laboratories to accelerate innovation.
- **Adaptive Systems Technology (AST)** focuses on generating creative pathways and natural interfaces between human and physical systems that will revolutionize the development of novel adaptive systems. This investment of $15.0 million in FY 2009 is motivated by the potential of new and transformational neuroscience discoveries to improve a wide range of systems and capabilities. AST is essential to advances in highly-innovative adaptive control systems, hybrid computer architectures, improved electronic PDAs, and computer-based, self-paced, learning and training tools.
- **Dynamics of Water Processes in the Environment (WATER)** is a $10.0 million, NSF-wide investment that aims to increase fundamental understanding of the Earth's freshwater systems and provide the scientific basis for decision-making about water resources. Major efforts in FY 2009 include fundamental research on the complex processes and feedbacks that affect the vulnerability and resilience of freshwater systems to climate and environmental change. This will help to define frontier research opportunities, delineate NSF's role in this area, and advance activities in foundational water systems research.

Support for Research Grants. Strong, sustained support for individual investigator and small group activities remains a priority for investments across the Foundation. With the 16 percent growth in Research and Related Activities, NSF anticipates supporting an additional 1,370 research grants. This will help to increase the funding rate to 23 percent from 21 percent, especially for unsolicited grants that potentially advance the frontiers of learning and discovery.

New Faculty and Young Investigators. Both the ACI and America COMPETES underscore the need to strengthen the Nation's science and engineering workforce, placing special emphasis on improving opportunities for scientists and engineers at the beginning of their careers. In keeping with this, CAREER – NSF's flagship program for young faculty – increases by over $14.0 million to $181.9 million. Other activities that traditionally involve young faculty – the Research Experiences for Undergraduates Program (REU) and Research in Undergraduate Institutions Program (RUI) – also increase.

Graduate Research Fellowships (GRF). 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. Funding for GRF in FY 2009 increases by $28.6 million (nearly 30 percent) to $124.8 million. This will support an estimated 3,075 fellows, an increase of 700 over the FY 2008 level. The GRF program recognizes the growing significance of the changing global environment for future scientists and engineers and is bringing more international emphasis and increasing opportunities for students to expand their knowledge of research and education in other nations and international issues affecting STEM careers.

Science and Technology Centers (STC). The FY 2009 Request includes $15.0 million for a competition to add five to seven new Science and Technology Centers. 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. Partnerships established by the STC Program go beyond the 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.

Cybersecurity. The FY 2009 Request includes $116.9 million for cybersecurity research and education, with $30.0 million specifically devoted respectively to research in usability ($10.0 million); theoretical foundations ($10.0 million); and privacy ($10.0 million) to support the Comprehensive National Cybersecurity Initiative. These investments in cybersecurity and information security and privacy will produce research results that allow society to more fully exploit the potential benefits of an increasingly networked world. In addition, the Scholarship for Service program, which funds scholarships to build a cadre of federal professionals with skills required to protect the Nation's critical information infrastructure, increases by 30 percent to $15.0 million.

International Science and Engineering. Funding for the Office of International Science and Engineering increases by nearly 15 percent to $47.4 million. A major focus in FY 2009 is the Partnerships for International Research and Education (PIRE) program, which increases by $3.0 million to $15.0 million. This program funds innovative, international collaborative research projects that link U.S. institutions and researchers at all career levels with premier international collaborators to work at the most promising frontiers of new knowledge.

Oceans Research. The FY 2009 Request provides continued strong support for a range of activities to ensure a clean, healthy, and stable ocean environment. $17.0 million is included for activities to support the interagency Ocean Research Priorities Plan. Investments in facilities for oceans research also increase significantly, with an increase of $21.8 million for the Integrated Ocean Drilling Program and the Academic Research Fleet.

Polar Facilities and Logistics. NSF's investments in the facilities and infrastructure needed to support polar research increase by $30.1 million. This includes increases for energy efficiency and fuel

conservation and major investments needed to ensure resupply capabilities for research facilities in the Antarctic. Also of note, NSF funding for U.S. Coast Guard (USCG) polar icebreakers decreases by $3.0 million, as beginning in FY 2009, NSF will no longer provide funds for maintaining the USCG's *Polar Star* in caretaker status.

Major Research Equipment and Facilities Construction (MREFC). Total MREFC funding decreases by $73.2 million (33 percent) in FY 2009. Support continues for three ongoing projects (the Atacama Large Millimeter Array, the IceCube Neutrino Observatory, and the Advanced Laser Interferometer Gravitational Wave Observatory). Also included is $2.5 million for design activities for the Advanced Technology Solar Telescope. Three projects (the Alaska Region Research Vessel, the National Ecological Observatory Network, and the Ocean Observatories Initiative) are not slated for additional MREFC funding in FY 2009, as each is currently completing design activities.

Enriching the Education of STEM Teachers. In FY 2009, a major focus of activities in NSF's Education and Human Resources (EHR) Directorate is Enriching the Education of Science, Technology, Engineering, and Mathematics Teachers (STEM). Major activities associated with this focus include the Math and Science Partnership program (up $2.5 million to $51.0 million) and the Robert Noyce Scholarship Program (up $800,000 to $11.6 million).

Promoting Learning through Research and Evaluation. The EHR Directorate is also increasing support for research and evaluation efforts in STEM education. Major efforts in FY 2009 include a $3.0 million increase to $10.0 million for Project and Program Evaluation and an $8.5 million increase to $108.5 million for Discovery Research K-12, which supports applied research and innovation aimed at improving STEM education at the K-12 level.

Broadening Participation. NSF remains a leader in efforts to broaden participation in science and engineering. This includes efforts to reach all states and regions, notably the Experimental Program to Stimulate Competitive Research (EPSCoR), which increases to $113.5 million in FY 2009. Efforts that focus on underrepresented groups also increase; examples include Alliances for Graduate Education and Professoriate (AGEP), the Historically Black Colleges and Universities-Undergraduate Program (HBCU-UP), the Louis Stokes Alliances for Minority Participation (LSAMP), and Centers of Research Excellence in Science and Technology (CREST). NSF has also made broadening participation a priority for program management and oversight, as is captured in the Stewardship goal for broadening participation presented in the Performance Information chapter.

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), the Climate Change Technology Program (CCTP), and Homeland Security.

INTERAGENCY R&D PRIORITIES
(Dollars in Millions)

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Request	Change over FY 2008 Estimate Amount	Change over FY 2008 Estimate Percent
National Nanotechnology Initiative	$388.69	$388.69	$396.79	$8.10	2.1%
Climate Change Science Program	206.63	205.25	220.60	15.35	7.5%
Climate Change Technology Program	21.00	21.00	23.50	2.50	11.9%
Networking and Information Technology R&D	908.45	931.48	1,090.25	158.77	17.0%
Homeland Security	388.76	368.41	379.17	10.76	2.9%

The Foundation will continue as a major participant in each of these areas in FY 2009, with increases for NNI, NITRD, and CCSP. 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.

Stewardship. The investments that support NSF's Stewardship goal – support excellence in science and engineering research and education through a capable and responsive organization – remain a priority in FY 2009, increasing by 13 percent to $404.3 million. The Request increases the NSF workforce by 50 staff to manage the growing and increasingly complex workload being experienced throughout the Foundation. Investments in information technology (IT) increase by 32 percent to $82.0 million, with emphasis on efforts to increase efficiency, productivity, and transparency in NSF's business processes. In this request, NSF's IT portfolio is realigned to tie funding for mission-related activities more directly to NSF's programs.

Delivering Results

NSF's FY 2009 Budget Request incorporates the Research and Development Investment Criteria outlined in the President's Management Agenda. This section describes 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 less than six percent of the agency's budget spent on internal operations – the remaining 94 percent 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. Investment decisions are guided by the agency's strategic goals, Administration initiatives articulated by the Office of Science and Technology Policy, and national priorities, as outlined in the ACI and America COMPETES.

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, implants, assistive devices, 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 nearly 90 percent of research and education funding going to awards selected through a competitive merit review process. In FY 2007, the last year for which complete data exist, NSF awarded nearly 11,500 new grants from roughly 45,000 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 cyber security. Reviewers also consider transformative potential and 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 2007, 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) conducts an annual assessment of NSF's performance with respect to the achievement of the agency's three program-focused strategic goals. In its FY 2007 report, the AC/GPA stated the following:

> The Committee was unanimous in its conclusion that NSF has demonstrated "Significant Achievement" for the strategic goals of Discovery, Learning, and Research Infrastructure. The Committee has based its opinion of "Significant Achievement" not only upon the quality, quantity, and outcomes of NSF-furnished highlights but also upon the overall performance across the agency as determined from other reports made available for review. From novel discoveries in the basic sciences and engineering to educational advancements across the Science, Technology, Engineering and Mathematics (STEM) disciplines, NSF has demonstrated continued commitment to its basic goals of pursuing the highest quality research, in innovative and transformative ways, while broadening the participation in science and engineering of people from all parts of society.

Stewardship Goal. To gauge progress under the Stewardship goal, NSF established eight performance areas for 2007 focusing on internal and customer-oriented priorities that emphasize effective and efficient management practices. NSF was fully successful in seven of the eight areas for FY 2007, with partial success in the remaining area (management of large facilities). These results were presented and discussed at the November 2007 meeting of the NSF Advisory Committee for Business and Operations and are discussed further in the Performance Information chapter of this Request.

Program Assessment Rating Tool. PART is an important component of NSF's performance activities. PART performance measures and action plans have provided valuable tools for program assessment and for improving program performance and management. To date, OMB has completed more than 1,000 PART assessments, representing 98% of all Federal programs; of those, only 18 percent received the highest rating of Effective. All NSF programs assessed to date received an Effective rating, with one additional assessment slated for completion in FY 2008.