# MANAGEMENT'S DISCUSSION AND ANALYSIS

## AGENCY PROFILE

### Mission and Vision

The National Science Foundation (NSF) is the steward of the nation's science and engineering enterprise. As an independent agency created by Congress in 1950, its mission is to promote and advance scientific progress in the United States by supporting all fields of fundamental science and engineering. Unlike other research agencies that focus on specific missions such as defense or health, NSF is the only federal agency responsible for the overall health of science and engineering across all disciplines. Its unique vision is articulated in the fiscal year (FY) 2003–2008 Strategic Plan, which guided FY 2006 activities, and in the FY 2006–2011 Strategic Plan, which was delivered to Congress on September 29, 2006, and will guide the agency in the future:[1] "Enabling the Nation's Future Through Discovery, Learning and Innovation: NSF investments—in people, in their ideas, and in the tools they use—will catalyze the strong progress in science and engineering needed to establish world leadership and secure the nation's security, prosperity, and well-being."

### The Public Benefits of a Strong Science and Technology Enterprise

U.S. investments in science and technology have long driven economic growth and improved the quality of life for successive generations. Science and technology have generated new knowledge and industries, created new jobs, provided new sources of energy, developed new modes of communication and transportation, and improved medical care. This process of scientific discovery and innovation has been critical to increasing the nation's productivity and sustaining economic growth. Today, more nations follow our lead in investing in science and technology, so the United States, in keeping with the President's American Competitiveness Initiative, must maintain its leadership in scientific discovery and new technologies in order to remain globally competitive.

NSF plays a critical role in fostering research of the highest quality—research that will generate important discoveries and new technology. As the FY 2006 research highlights on the following page and throughout this report clearly demonstrate, this work has a positive impact on the nation. For example, NSF supported research efforts in the physical sciences, social and economic sciences and engineering research related to the catastrophic flooding in the southeastern United States, including one study that determined how and why numerous levees failed. The results will allow engineers to improve their plans for repairs. Also, NSF-supported researchers devised an ultra-tiny electrical valve (or diode) that is composed of only a single molecule and is a thousand times smaller than current valves. This research could lead to a whole new era of miniaturization in electronic components.

Despite its small size, NSF has had an extraordinary impact on the nation's scientific knowledge and capacity. NSF has funded the groundbreaking research of 174 Nobel Prize winners and thousands of other distinguished scientists and engineers.[2] The remarkable progress in science and engineering that has defined the United States since World War II reflects the strength of our basic research enterprise. Moreover, not since World War II have advances at the frontiers of knowledge been more critical for national security. Advanced capability in materials science research, sensors and sensor network

[1] NSF's current Strategic Plan, *Investing in America's Future: Strategic Plan FY 2006–2010*, is available at www.nsf.gov/pubs/2006/nsf0648/NSF-06-48.pdf. The FY 2003–2008 Strategic Plan is available at www.nsf.gov/pubs/2004/nsf04201/FY2003-2008.pdf.

[2] See www.nsf.gov/news/news_summ.jsp?cntn_id=108098&org=NSF&from=news for a list of the Nobel laureates who have received NSF support.

architecture, genomics, cyber-security, and data mining, as well as knowledge of human and social dynamics, have a direct impact on present and future homeland security systems and capacity.

## FY 2006 Research Highlights

The following are some results reported by NSF-supported researchers in FY 2006:

- Conducted extensive on-site research in and around New Orleans following Hurricane Katrina, and published an analysis explaining how and why numerous levees failed, allowing engineers to improve plans for repairs
- Observed the astronomical results of a two-galaxy smashup and announced the first "direct detection" of the mysterious, invisible "dark matter" that is a major component of the universe but neither emits nor reflects light
- Provided novel telecommunications and computerized early-warning systems that gave critical information to separate teams fighting a dangerous outbreak of wildfires in California
- Issued advance warning of the increased risk of a potentially lethal microbe called Hantavirus that has plagued the Four Corners area of the southwest United States
- Launched a major, multiyear program to record and study dozens of dying languages – those spoken by only a few people and doomed to disappear completely soon – so that knowledge will not be lost to humanity
- Compiled a forecast indicating that the next 11-year sunspot cycle, with its associated "solar storms" that can damage key communications satellites and cause widespread blackouts in power grids, will be at least 30 percent stronger than the last
- Showed that there is a direct link between the number of species in an ecosystem and its ability to survive environmental and other threats
- Uncovered a new method of detecting and identifying cancer genes by mathematically analyzing the output of "gene chips," and tested the method successfully in lung cancer cases
- Undertook a wholesale reevaluation of high-school advanced placement courses in math and science, which are now in drastic need of updating to give students the information and insight they will need in college
- Discovered and characterized a "super glue" produced by bacteria that is completely waterproof and three to five times stronger than any commercial adhesive available – capable of withstanding a pull of five tons per square inch
- Unearthed a remarkable fossil – unlike anything else ever discovered in the region – that is the oldest example of a creature that inhabited the evolutionary gap between fish and land animals
- Devised an ultra-tiny electrical valve (or diode) that is made of only a single molecule – a thousand times smaller than its current counterparts – thus raising the possibility of an entirely new era of miniaturization in electronic components
- Determined that infants less than one year old have an innate sense of numbers, which they are able to employ many months before they are even able to talk – much less do arithmetic.
- Produced the first computer simulation of the workings of every atom in a virus, the first time any complete life form has been mapped in its entirety
- Sent a new, high-altitude research plane, built to fly miles above commercial jets, on its first successful science missions to examine the contents and activity of atmosphere at new heights
- Constructed a new generation of two-legged robots that can walk like human being

For more information on the research results described here, see www.nsf.gov/discoveries/.

## NSF Leadership in U.S. Academic Basic Research

*Figure 1* Federal Support for Research and Development

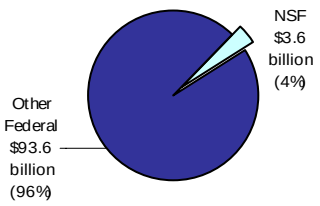
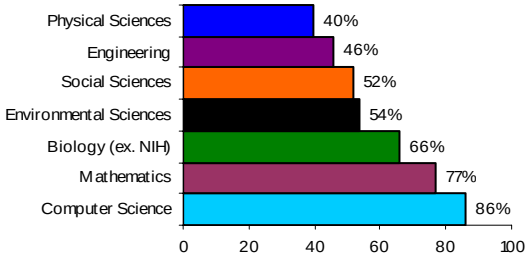



*Figure 2.* NSF Support as a Percent of Total Federal Support of Academic Basic Research in Selected Fields

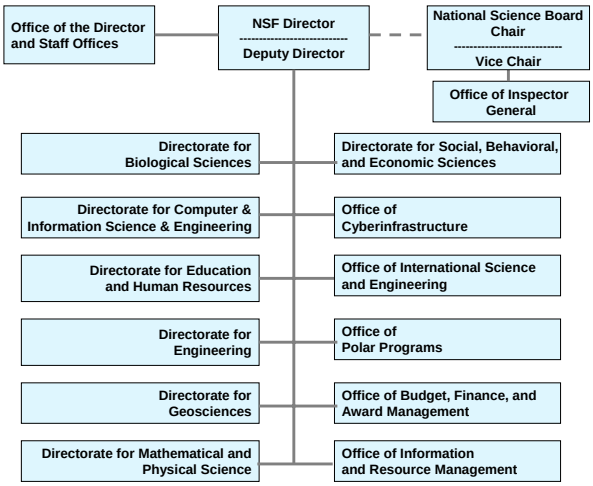



The support of academic research is critical to sustaining future generations of world-class scientists and engineers who will develop the ideas and research tools needed to address the challenges we face now and in the future. Although NSF represents only 4 percent of the total federal research and development (R&D) budget, it is the second largest funding source for R&D at colleges and universities. In fact, NSF is the primary source of federal academic support for basic research in many fields, including computer science, environmental sciences, mathematics, social sciences, and nonmedical biology (see Figures 1 and 2).[3] Although NSF does not directly fund medical research, its support benefits medical science and related industries, leading to advances in diagnosis, regenerative medicine, drug delivery, and pharmaceutical design and processing. NSF-supported fundamental research in physics, mathematics, and high-flux magnets led to the development of magnetic resonance imaging, which is widely used in medicine today.

## Organizational Structure

NSF is funded primarily by congressional appropriations and is headed by a Director who is appointed by the President and confirmed by the Senate. NSF has seven directorates and three program offices organized by disciplinary area and programmatic activity, in addition to two management offices that are responsible for business and operations (see Figure 3). A description of each directorate and office can be found in Appendix 1. A 24-member National Science Board (NSB), also appointed by the President with the consent of the Senate, meets about six times a year to establish overall policy. NSB serves the President and Congress by acting as an independent advisory body on policies related to the U.S. science and engineering enterprise.

*Figure 3.*
National Science Foundation Organization



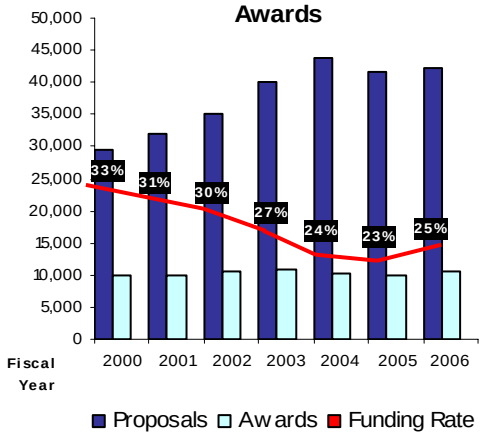

[3] Source for Figures 1 and 2: NSF/SRS/R&D Statistics Program, *Survey of Federal Funds for Research and Development: FY 2002–2004.*

The NSF workforce includes about 1,400 full-time staff; roughly 85 percent are permanent employees and the rest are "rotators." To complement the permanent workforce, NSF regularly recruits visiting scientists, engineers, and educators who are leaders in their fields. These rotators usually spend one to three years with the agency. Recruiting active researchers and educators to fill rotating assignments infuses new talent and expertise into NSF and is integral to the mission of supporting the entire spectrum of science and engineering research and education and advancing the frontiers of discovery and learning.[4] NSF currently has about 180 rotators, as well as contractors engaged in commercial administrative activities.

## How NSF Works

NSF directly supports scientists, engineers, and educators through their home institutions (usually colleges and universities). With the exception of polar operations, NSF does not maintain its own facilities or laboratories. In FY 2006, NSF received 42,377 proposals, a 1.6 percent increase over the previous year. A total of 10,450 new awards were funded to more than 1,700 colleges, universities, and other public institutions throughout the country (see Figure 4). Nearly 90 percent of NSF funding was allocated through a merit-based competitive process that is recognized throughout the government as the gold standard for the responsible use of public funds.[5] Each year, 42,000 members of the science and engineering community serve as panelists and proposal reviewers under the merit review process.

***Figure 4.***
**Number of NSF Proposals and Awards**




In FY 2006, NSF awards directly involved an estimated 170,000 people, including senior researchers, postdoctoral associates, teachers, and students from kindergarten through graduate school. NSF's investment portfolio is a rich mix of programs and partnerships that reach broad and diverse segments of the science and engineering research and education community, as well as the general public. The following are examples of projects funded by NSF in FY 2006; to see others, visit the NSF website at www.nsf.gov.

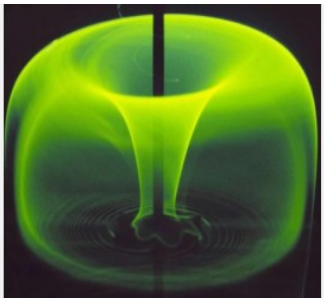
▶ Sequencing the maize (corn) genome has been considered a daunting task because of its size and complexity. With two smaller plant genomes—rice and the model laboratory plant *Arabidopsis*—now complete, a team of university and private research scientists is analyzing the 2.5 billion bases of the maize genetic code. This team has been awarded a total of $32 million from NSF, the Department of Agriculture, and the Department of Energy (DOE) to sequence the maize genome. The award is another step in using genomics to transform the plant sciences and help researchers increase yields, reduce inputs, and develop more disease-resistant varieties, as well as improve the growth and development of other related grass crops such as wheat and barley. This project will provide an essential

[4] Temporary appointments are made under the Intergovernmental Personnel Act (IPA), funded through program accounts, or under the Visiting Scientists, Engineers, and Educators (VSEE) Program, funded through administrative accounts. Appointments are counted as federal full-time-equivalent staff. In October 2006, NSF staff included 135 IPAs and 42 VSEEs.

[5] For additional information about NSF's merit review process, see *Report to the National Science Board on NSF's Merit Review Process, FY 2005*, at www.nsf.gov/publications/pub_summ.jsp?ods_key=nsb0621.

overview of the structure and function of genes that define the corn plant, which ranks among the world's major grain crops and dominates U.S. agriculture. Corn is not only grown for food and feed, but it is also the source of a variety of processed foods: Literally thousands of products in the typical supermarket contain corn. In addition, it is an important raw material for many industrial products including rubber, plastics, fuel, and clothing.

▶ NSF awarded $75.3 million for five new Engineering Research Centers (ERCs) that will develop cross-disciplinary programs to advance technologies to address major societal problems and provide the basis for new industries. Scientists and engineers from a variety of disciplines collaborate on broad-based high-risk engineering research, developing fundamental knowledge and test beds for emerging technologies. The ERCs also provide rich educational and research environments for preparing new generations of engineering leaders. The five centers will pursue breakthroughs in synthetic biology, fluid power, air monitoring, drug manufacturing, and technologies for older adults and people with disabilities. In the image at left, a fluorescent dye injected into a tank of stirred liquid creates a pattern that resembles a green apple. The demonstration, conducted by Rutgers researchers from the NSF Engineering Research Center for Structured Organic Composites, shows how liquids mix in a typical pharmaceutical manufacturing operation. This research will help enhance drug quality while reducing the cost of developing and manufacturing new drugs. *(Image courtesy of M. M. Alvarez, T. Shinbrot, and F. J. Muzzio, Rutgers University, Engineering Research Center for Structured Organic Composites)*



▶ NSF awarded nearly $12 million to the California Institute of Technology (Caltech) for the development of software to analyze neutron-scattering experiments. Neutron scattering looks at the position and motion of the atoms that make up materials, molecules, and condensed matter at various temperatures and pressures to analyze their stability. This work could affect the design of new materials for a huge variety of applications in transportation, construction, electronics, and space exploration. According to project leader Brent Fultz, Professor of Material Science and Applied Physics at Caltech, the research will eventually show how new materials can be optimized for mechanical strength, electrical conductivity, energy storage, and resistance to corrosion. Using data from facilities such as DOE's new Spallation Neutron Source (SNS) in Oak Ridge, Tennessee, this project will integrate new materials theory with high-performance computing. The image at right shows Rick Martineau of Los Alamos National Laboratory conducting a final inspection of an SNS component before it is shipped. *(Image courtesy of Leroy N. Sanchez, Los Alamos National Laboratory)*

▶ NSF awarded a $1.8 million grant to the College Board to redesign Advanced Placement (AP) courses in biology, chemistry, physics, and environmental science. Studies have shown that U.S. high school students continue to fall farther behind other nations in their ability to apply scientific concepts and skills, and the percentage of U.S. undergraduates earning degrees in science and engineering is far below that of other competitive nations. AP students are an important exception. Research indicates that U.S. students who take AP math and science courses have a higher level of proficiency than students from all other nations. AP students are also much more likely to major in science, technology, engineering, and mathematics (STEM) disciplines

than students who are first exposed to college-level math and science courses in college. Changes to the AP science program will reflect the latest research on how students learn. The redesign will emphasize depth of understanding so that students will be better equipped to navigate complex content and to transfer their knowledge during assessments. *(Image credit: AbelStock)*

## The President's Management Agenda

NSF's leadership and commitment to making government more effective are demonstrated by its ratings on the President's Management Agenda (PMA) scorecard (see Figure 5). In the fourth quarter of FY 2006, NSF was one of only five agencies to achieve "Green" status in four or more of the five primary initiatives. NSF also achieved "Green" status and progress ratings for the *Eliminating Improper Payments* initiative.[6]

***Figure 5.***
**President's Management Agenda Scorecard**

| | Baseline | Status | Progress |
|---|---|---|---|
| | Sept. 30, 2001 | Sept. 30, 2006 | |
| Strategic Management of Human Capital | R | G | G |
| Competitive Sourcing | R | R | R |
| Improving Financial Performance | G | G | G |
| Expanded E-Government | Y | G | G |
| Budget and Performance Integration | R | G | G |

Notes:

In FY 2006 Q4, NSF also received green status and progress ratings for the Eliminating Improper Payments initiative.

Green (G) indicates success; Yellow (Y), mixed results; and Red (R) unsatisfactory. Ratings are issued quarterly by OMB.

▶ NSF maintained its "Green" status in *Strategic Management of Human Capital* for the second consecutive year. Several key initiatives contributed to continued success in this area. The Administrative Function Study, which is addressing the changing nature of work in the program directorates, is in the early stages of implementation. Workforce and staff planning initiatives are helping to give leaders the tools they need to make better informed decisions on human capital, ultimately leading to a workforce that complements NSF's dynamic and unique staffing needs. In the Division of Human Resources Management (HRM), NSF is implementing a new integrated Service Team approach that focuses on partnering with program directorates to plan and anticipate human capital requirements. This approach will also emphasize coordination and communication within HRM and between HRM and NSF customers to improve responsiveness and reduce processing time. Further, a Learning Management System, called AcademyLearn, is being implemented to improve the coordination of training and development opportunities and to facilitate better connections between those opportunities and the needs of NSF organizations.

▶ NSF continues to be rated "Red" in *Competitive Sourcing.* In FY 2006, NSF completed its first public-private competition to strengthen technical and administrative support services within the Office of Budget, Finance, and Award Management. The competition was specifically tailored to address a concern identified in the *FY 2004 Financial Statement Audit Report*, which called for resources dedicated to improving post-award monitoring of grant, contract, and cooperative agreement activities. NSF continues to work with the Office of Management and Budget (OMB) to consider other potential opportunities for competitive sourcing.

[6] For more information on PMA and NSF's scorecard, see www.ExpectMore.gov, www.whitehouse.gov/results, and www.whitehouse.gov/results/agenda/scorecard.html.

▶ NSF has maintained its "Green" rating in *Improving Financial Performance* since 2001, when it was the only agency to receive a baseline "Green" rating. In FY 2006, NSF maintained consistently high scores on the Chief Financial Officers (CFO) Council Metric Tracking Scorecard and consistently earned "Green" ratings for the accuracy and timeliness of financial reporting on the Treasury Department's Financial Management Scorecard. In addition, NSF transformed its Cost and Performance Integration Work Plan into a "Next Steps Budget and Performance Integration (BPI) and Financial Performance Combined Work Plan." The centerpiece of this plan is the integration of the standards for BPI and Financial Performance, since these standards focus directly on information for agency reporting and decision making.

To improve the management and monitoring of travel funds, NSF implemented a new Guest Travel System that improves funds control, automates important reporting processes, and provides real-time information in specific areas. NSF also completed the initial development of a facilities tracking system that provides management and staff with improved real-time financial reporting capability, capturing specific facility data throughout the agency by life-cycle phase. This information will ultimately link directly to the related budget process.

NSF senior managers continue to meet at least quarterly to review integrated financial and performance information that covers all major areas of responsibility. The Enterprise Information System (EIS), the Financial Accounting System (FAS), and Report.web make financial, budgetary, awards, and performance data (including the Program Assessment Rating Tool, or PART) widely accessible in various formats to all NSF employees. Managers use this information to make decisions relating to budget priorities and business processes.

▶ NSF has successfully maintained its "Green" rating in *Expanded e-Government (e-Gov)* for five consecutive years. NSF is a federal leader in the use of information technology, actively promoting simpler, faster, more accurate, and less expensive electronic business solutions. Virtually all of NSF's business interactions with the external grantee community have been conducted electronically since 2000. The agency is actively engaged in supporting numerous e-Gov initiatives. NSF is a Grants.gov partner agency, co-chaired the Grants Management Line of Business (GMLoB) task force, and currently co-leads the GMLoB, which is using a consortium-based approach to develop service centers around functional and grant-type competencies. In FY 2006, OMB selected NSF as one of three initial consortia leaders. In FY 2006, NSF posted 100 percent of funding opportunities on Grants.gov Find and 75 percent of discretionary grant application packages on Grants.gov Apply. FastLane, NSF's flagship application, is an interactive real-time system that is used to conduct business with the grantee community over the Internet and interfaces with Grants.gov. Enhancements to the Electronic Jacket System (e-Jacket), a web-based application designed to process proposals electronically, provide more customer-friendly capabilities, enhanced accessibility, and a streamlined workflow, thereby resulting in significant efficiency and productivity savings.

Security of information technology (IT) systems remains a management priority of the highest importance. NSF has continued to make enhancements to an already strong security program by incorporating new guidance and best practices into its IT environment. All major NSF systems have current certification and accreditation. The IT environment is aggressively monitored, and an automated enterprise vulnerability management tool has been implemented to streamline compliance with security policies and reduce risk. Annual security awareness training is mandated and tracked for all users of NSF IT resources, and training is updated to reflect new privacy and security risks. The FY 2006 Federal Information Security Management process recognized NSF's established information security program and the proactive review of security controls and areas to improve. NSF uses a plan of action and milestones to monitor the implementation of enhancements to further strengthen the IT security program.

Recognizing that there are always risks, NSF continues to monitor and enhance its security program and integrates security into all of its business practices.

▶ NSF maintained its "Green" status for *Budget and Performance Integration.* This year's efforts have emphasized improvements to tracking the costs of large facility projects, upgrades to the EIS, and direct links between budget line items and the FAS. A major activity under this initiative is evaluating programs using PART. NSF is the only agency that has received the highest rating of "Effective" in all of its PART program evaluations from OMB. Of the nearly 800 federal programs that have been evaluated by PART, only 15 percent have been rated as effective. NSF's successful PART results reflect a diligent staff and a competitive awards process that helps ensure relevance, quality, and performance, which are key components of the Administration's R&D Criteria.

## Meeting Future Opportunities and Challenges

NSF is well positioned to maximize the opportunities and face the challenges of the future. The President's American Competitiveness Initiative (ACI) outlines a 10-year doubling of investments in NSF and other agencies that are the principal supporters of the physical sciences and engineering. To fulfill its ACI obligations, NSF will direct its funding toward generating fundamental discoveries that produce valuable and marketable technologies, providing world-class facilities and infrastructure that will transform research and enable discovery, and helping the nation's STEM workforce prepare for the 21st century while improving the quality of math and science education in U.S. schools. With a new strategic plan in place beginning in FY 2007, NSF will direct its efforts toward two new crosscutting objectives: "To Inspire and Transform" and "To Grow and Develop."

As it pursues these activities, NSF will seek partners and nurture cooperation among government, industry, and academia. With discoveries emerging in many countries, it is essential that U.S. scientists and engineers have the opportunity to interact with other top researchers, to lead major international collaborations, and to have access to the best research facilities throughout the world. With offices in Paris, Tokyo, and Beijing (the Beijing office was established earlier this year), NSF can more effectively participate in the international arena and facilitate education initiatives that will help build greater capacity for multinational collaboration. As the lead federal agency for the National Nanotechnology Initiative, NSF will continue to provide critical support for efforts in fundamental nanoscale science and engineering. As the lead federal agency for the International Polar Year project that runs from March 2007 to March 2009, NSF will head an interagency, international effort to understand the Earth's extreme latitudes at scales from the global to the molecular. Of highest priority is the support of frontier research that meets pressing national needs in security, energy, the environment, and health.

The successful achievement of NSF's strategic outcome goals in FY 2006 and in past years reflects a continuing commitment to excellent, results-oriented management and stewardship. The PMA scorecard and PART results, which are among the best in government, clearly demonstrate this commitment. NSF has an established record of success in leveraging its agile, motivated workforce, management processes, and technological resources to enhance productivity and effectiveness. The agency is also recognized within government for its financial management and electronic business acumen. Historically, about 95 percent of NSF's budget supports the conduct of research and education, with administrative overhead accounting for only about 5 percent.

The ongoing quest for organizational excellence will direct management's focus to a number of opportunities and challenges. The rise in multidisciplinary collaborative projects, international activities, and major research facility projects has increased the complexity of the workload, and although NSF's budget has increased 70 percent over the past 10 years, staffing has increased less than 10 percent. In

addition, meeting new external administrative, oversight, and accountability requirements is an additional burden on limited staffing and funding resources. This year's establishment of a new internal control process to meet OMB's revised A–123 guidance was a major undertaking that will continue for the next 2 years as NSF works toward achieving an unqualified management assurance. In addition to being one of the initial three consortia leaders in the GMLoB, NSF will remain actively engaged in supporting numerous other e-Gov activities, including e-Human Resources, the Integrated Acquisition Environment, e-Authentication, and the Lines of Business initiatives.

In FY 2002, NSF embarked on a Business Analysis study to address the fundamental challenges it faces as it becomes a fully integrated organization with increased capabilities for working both inside and across traditional disciplinary and organizational boundaries. The study was concluded in FY 2006. It identified desired outcomes that are influencing current operational strategies and supported several PMA initiatives. Specifically, it supported the update to NSF's 2003–2008 Strategic Plan; continued the implementation of a number of improvements in the Merit Review and Award Management and Oversight processes; completed the study phase of the Administrative Function Study and moved into the implementation phase; and continued designing the Target Enterprise Architecture, which, when implemented, will allow NSF to better monitor its IT investments and overall project and risk management. The Business Analysis team has prepared final reports that NSF can use to further implement study findings.