UNITED STATES

National Science Foundation

FY 2008 ANNUAL PERFORMANCE REPORT

Advancing Discovery, Innovation, & Education

Pursuant to OMB Circular A-136, the National Science Foundation is following the Office of Management and Budget (OMB) Pilot Program for Alternative Approaches to Performance and Accountability Reporting. This pilot, which was initiated in Fiscal Year (FY) 2007, is an alternative to the consolidated Performance and Accountability Report (PAR) published in previous years. The National Science Foundation (NSF) anticipates that this approach will improve its performance reporting by presenting performance information in a more accessible and informative format, and that performance information will be more complete given additional time to collect actual year-end performance data. As part of this project, NSF is producing the following annual reports for FY 2008, available on NSF's website at http://www.nsf.gov/about/performance/.

- **FY 2008 Annual Financial Report (AFR).** The **AFR** focuses on NSF's financial management, the results of the agency's annual financial audit, and its compliance with the Federal Managers' Financial Integrity Act (FMFIA) and the Federal Financial Management Improvement Act (FFMIA). The AFR was published on November 17, 2008, and is available on the NSF website.

- **FY 2008 Citizens' Report**, previously known as NSF's Performance Highlights report, summarizes key performance and financial information.

- **FY 2008 Annual Performance Report (APR).** The **APR** presents the results of NSF's FY 2008 Government Performance Results Act (GPRA) strategic outcome goals and a comprehensive discussion of NSF's performance assessment process. It also contains the results for the agency's annual goals. NSF's budget and performance website includes additional, more detailed performance information.

For more information about the National Science Foundation, visit NSF's website at www.nsf.gov.

To obtain copies of this report, please send your request to Accountability@nsf.gov.

We welcome suggestions on how to make this report more informative. Please provide your comments to Patricia Tsuchitani, 4201 Wilson Blvd., Arlington, VA 22230. (ptsuchit@nsf.gov)

About the cover: An NSF-supported University of Washington-led team has taken a sample of mud collected at Lake Washington and successfully sequenced a complete genome for an unknown microorganism. Their method provides a way to discover new microscopic life in complex communities. Using the genetic technique of metagenomics, University of Washington researchers have revealed the possibility to uncover the genomes of unknown species with this approach. This is a particularly important finding for microbial research since few microbes survive in the lab and have therefore gone largely unidentified. Such techniques could allow scientists and engineers to identify microbial species based on particular, desired functions and to develop such microbes for practical applications.

Shown on the cover are microorganisms from a mud sample collected in Lake Washington. For more information see www.nsf.gov/news/news_summ.jsp?cntn_id=112138&org=NSF&from=news.

Credit: Photo by Dennis Kunkel (Dennis Kunkel Microscopy, Inc.); color by E. Letypova (University of Washington)

MESSAGE FROM THE DIRECTOR

I am pleased to share with you the *Annual Performance Report (APR)* of the National Science Foundation (NSF) for Fiscal Year (FY) 2008. This report focuses on the agency's performance achievements against our Strategic Plan and identifies important outcomes of our investments across all fields of science and engineering, and all levels of science and engineering education. It also describes significant achievements in improving the effectiveness and efficiency of agency operations.

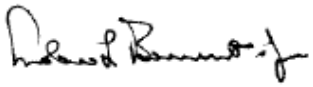
The outcomes, or returns on our investments, highlighted in this report are only a small portion of the discoveries and accomplishments reported throughout the year by NSF- supported principal investigators, which are featured on NSF's website (see Discoveries on http://www.nsf.gov). More information about the results of NSF's research spending and results is also available on the Research.gov website: http://www.research.gov/.

As you will see in the report, NSF successfully met all four of its strategic outcome goals in FY 2008. For three of the goals -- Discovery, Learning, and Research Infrastructure -- this success was based upon the external, expert review by the NSF Advisory Committee for GPRA Performance Assessment (AC/GPA). The AC/GPA determined that NSF had demonstrated significant achievement toward each goal. For NSF's Stewardship goal, the success is based on the accomplishment of a majority of the performance milestones and measures related to its programs and its operations and management of resources.

For a second year, NSF is participating in the Office of Management and Budget's Pilot Program for Alternative Approaches to Performance and Accountability Reporting, which contains the following components: the *FY 2008 Annual Financial Report (AFR)*, published on November 17, 2008; the *FY 2008 Citizens' Report*, which contains key performance and financial information; and the *FY 2008 Annual Performance Report*. All reports are available on NSF's website at http://www.nsf.gov/about/performance/.

I am pleased to report that the performance data in the *FY 2008 Annual Performance Report* are complete and reliable. All our performance goals were verified and validated by an independent management consulting firm, IBM Global Business Services. IBM completed a Verification and Validation (V&V) review of the performance data and information based on guidelines issued by the Government Accountability Office (GAO).

Thank you again for your interest in the National Science Foundation and the performance of its investments in science and engineering research and education.



Arden L. Bement, Jr.
Director

January 15, 2009

NATIONAL SCIENCE FOUNDATION
FY 2008 Annual Performance Report

The National Science Foundation: Who We Are and What We Do

The National Science Foundation (NSF), an independent agency created by Congress nearly 60 years ago, is the premier federal agency supporting basic research across all fields, and science and engineering education at all levels. Unlike many other federal agencies, NSF does not conduct research or directly operate its own laboratories. NSF funds scientists and engineers and educators at colleges and universities, as well as other institutions, through competitive, merit-based review of proposals. NSF also funds research centers, advanced instrumentation, and large facilities such as giant optical and radio telescopes, Antarctic research sites, high-end computer facilities, ships for ocean research, sensitive detectors of very subtle physical phenomena, and gravitational wave observatories. NSF is also the principal federal agency that promotes science and engineering education, and is the federal statistical agency that collects and analyzes data related to the entire science and engineering enterprise.

NSF's annual budget is about $6 billion, which represents less than four percent of the total federal budget for research and development. Nevertheless, the Foundation provides nearly half of the federal support for non-medical basic research at U.S. colleges and universities. In many fields, such as biology, computer science, environmental sciences, mathematics, and the social sciences, NSF is a major source of federal academic research, as illustrated in Figure 1.

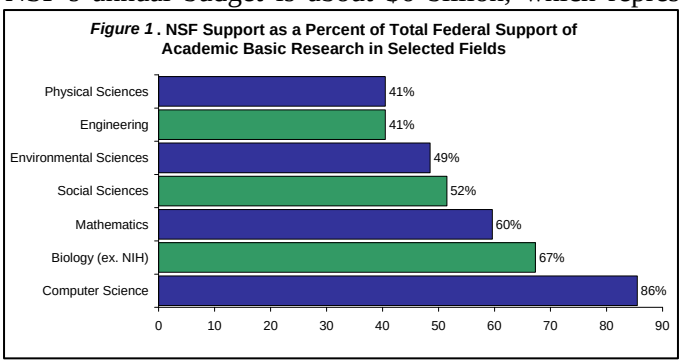


***Figure 1*. NSF Support as a Percent of Total Federal Support of Academic Basic Research in Selected Fields**

NSF's competitive, merit-based review process relies heavily on scientists, engineers, and educators throughout the world to provide rigorous and objective evaluation of the intellectual merit and broader impacts of proposals. In Fiscal Year 2008, about 248,000 persons served as ad-hoc reviewers for NSF proposals. Of that number, about 50,000 served on review panels.

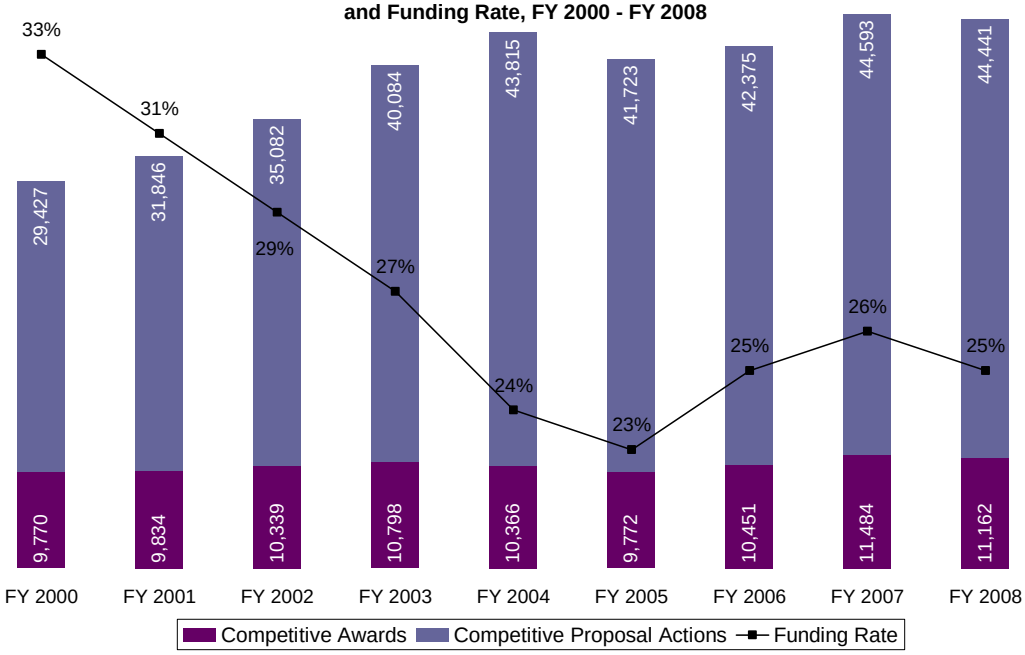
NSF's task of identifying and funding the most promising work is not a "top-down" process. Rather, NSF operates from the "bottom up," using a variety of mechanisms to generate proposals. About 80 percent of research proposals received are "unsolicited" submissions to programs that invite research ideas in promising and important areas. The remaining 20 percent are submitted in response to a specific program solicitation, which NSF uses to stimulate interest in a new area and develop a nascent scientific community. All funding opportunities are prominently displayed on NSF's website, www.nsf.gov

Proposals to NSF are evaluated using two criteria approved by the National Science Board: intellectual merit and broader impacts. Consideration is also given to 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. Additional criteria, as stated in individual program announcements or solicitations, may also be required. About 97 percent of NSF's proposals are evaluated by external reviewers as well as by NSF staff[1].

[1] For more information about NSF's merit review process, see *Report to the National Science Board on the National Science Foundation's Merit Review Process, FY 2007* at http://www.nsf.gov/nsb/publications/2008/nsb0847_merit_review_2007.pdf

The competition for NSF funds is intense. To address this challenge, NSF is pursuing a variety of approaches that balance trade-offs between keeping the proposal workload at a productive and manageable level—for both NSF and the applicant community—and encouraging the free flow of ideas to NSF. Figure 2 illustrates the funding rate trend from FY 2000 through FY 2008.

Figure 2. **Number of NSF Competitive Proposals and Awards and Funding Rate, FY 2000 - FY 2008**



In Fiscal Year 2008, NSF awards went to more than 1,900 colleges, universities, and other institutions, and supported more than 197,000 people (researchers, postdoctoral fellows, trainees, students, and teachers). Information on the numbers of actions and awards, as well as funding rates, is available on each Directorate's homepage on the NSF website: www.nsf.gov

NSF uses three kinds of funding mechanisms: grants, cooperative agreements, and contracts. Most of NSF's projects support scientific and engineering research and education, and are funded through grants or cooperative agreements. A grant may be funded as a standard award, in which funding for the full duration of the project, generally one to five years, is awarded in a single fiscal year) or a continuing award (in which funding of a multi-year project is usually provided in annual increments). Cooperative agreements are used when the project requires substantial agency involvement during the project performance period (e.g. research centers, multi-user facilities). Contracts are used to acquire products, services, and studies (e.g. program evaluations) required primarily for NSF or other government use. In Fiscal Year 2008, NSF devoted 41 percent of its total budget to new standard and new continuing grants. The use of standard and continuing grants shows NSF's flexibility in balancing current and future obligations.

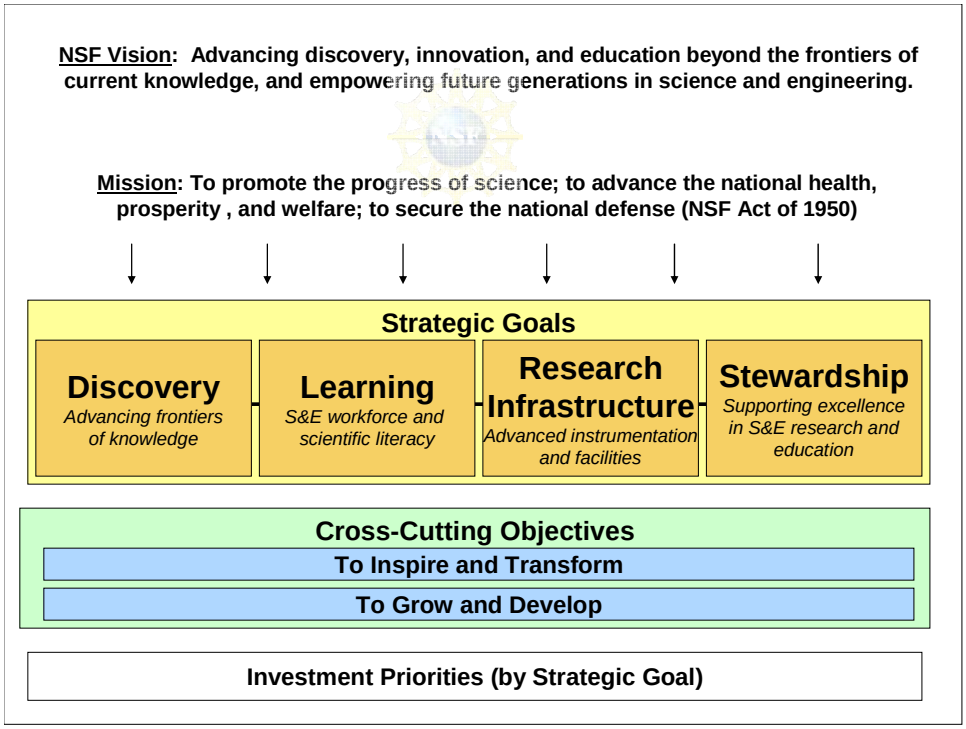
With about 11,000 new awards issued each year, NSF's portfolio is continually realigned and refocused on the most promising ideas and emerging talents. Roughly one-third of NSF's 500 program officers are on temporary assignments from their home institutions, bringing their wisdom, input, and guidance. NSF is committed to supporting research conducted at the nation's colleges and universities, which ensures that the pursuit of new knowledge occurs in tandem with the development of the next generation of scientists, engineers, and educators. The integration of research and education is a hallmark of the National Science Foundation.

Goals and Objectives

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 this process provide stakeholders and taxpayers with vital information about the return on their investments. In Fiscal Year 2008, performance assessment at NSF was guided by the Government Performance and Results Act of 1993 (GPRA) and by NSF's *FY 2006–2011 Strategic Plan.*[2]

To accomplish its mission to promote the progress of science and engineering, NSF invests in the best ideas generated by scientists, engineers, and educators across all fields of research and education. NSF's Strategic Plan establishes four overarching strategic outcome goals by which NSF measures its annual performance: *Discovery*, *Learning*, *Research Infrastructure*, and *Stewardship*. The four goals establish an integrated strategy to deliver new knowledge, meet vital national needs, and work to achieve the NSF vision. The first three goals focus on NSF's long-term investments in science and engineering research and education. The fourth goal, *Stewardship*, focuses on improving the effectiveness and efficiency of the agency's operations and services to the science, engineering, and education community.

Figure 4. **NSF Strategic Framework**



NSF's performance assessment framework and process is based on this strategic framework. For more information, see pages 5 – 7.

[2] NSF's *FY 2006–FY 2011 Strategic Plan* is available at www.nsf.gov/pubs/2006/nsf0648/nsf0648.jsp.

Summary of Fiscal Year 2008 Performance Goal Results

In Fiscal Year 2008, the National Science Foundation:

- **successfully met its performance objectives by demonstrating *significant achievement* for the three long-term, qualitative, strategic outcome goals in its 2006-2011 Strategic Plan: *Discovery*, *Learning*, and *Research Infrastructure*, according to an independent evaluation by the NSF Advisory Committee for GPRA Performance Assessment; [3]**

- **achieved 22 out of 23 annual performance milestones and measures under the fourth strategic outcome goal of *Stewardship*;**

- **met 17 out of 23 targets (74 percent) in its Program Assessment Rating Tool (PART) performance measures.**

Figure 5 illustrates that the Foundation achieved success under its three long-term strategic outcome goals during the Fiscal Years 2004 – 2008, as evaluated by the AC/GPA. It also indicates success for the Stewardship goal during Fiscal Years 2007 and 2008, the two years in which this goal became effective under the current Strategic Plan. Figure 6 on the next page shows five-year results for NSF's PART performance measures. Detailed information on the results of all goals may be found in Appendices A through C.

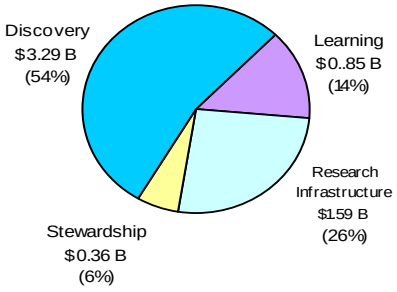
Figure 5. **Strategic Outcome Goals and Results**

Performance Goal	Results
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 2004 ● FY 2005 ● FY 2006 ● FY 2007 ● FY 2008
LEARNING Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.	● FY 2004 ● FY 2005 ● FY 2006 ● FY 2007 ● FY 2008
RESEARCH INFRASTRUCTURE Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure, and experimental tools.	● FY 2004 ● FY 2005 ● FY 2006 ● FY 2007 ● FY 2008
STEWARDSHIP Support excellence in science and engineering research and education through a capable and responsive organization.	● FY 2007 ● FY 2008

[3] For more information about the evaluation see the *Report of the Advisory Committee for GPRA Performance Assessment, FY 2008* at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08064.

Figure 6. PART Performance Measures Number and Percent Achieved, FY 2004 – FY 2008					
	FY 2004	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**
Annual Performance Measures	23 of 26 (88%)	14 of 17 (82%)	15 of 22 (68%)	14 of 20 (70%)	17 of23 (74%)

Figure 7.
FY 2008 Budget Obligations
$6.08 Billion*



**Totals may not add due to rounding.*

In Fiscal Year 2008, grants for research and education under *Discovery*, *Learning*, and *Research Infrastructure* accounted for 94 percent of NSF's investment portfolio (*Figure 7).*[4] Outcomes under these goals are assessed annually by an external review panel, the Advisory Committee for GPRA Performance Assessment (AC/GPA), composed of experts in various disciplines and fields of science, engineering, mathematics, and education.[5] *Stewardship* accounts for six percent of NSF's portfolio, and includes several performance milestones and measures of efficiency and effectiveness that are monitored within the agency. Examples of *Stewardship* performance areas are time to decision (proposal dwell time), merit review, customer service, broadening participation, post-award monitoring, E-Government, IT security, and management of NSF's large facilities.

Performance Assessment Framework

Assessing the Outcomes of the Long-Term Strategic Outcome Goals: Discovery, Learning, and Research Infrastructure

As stated above, in Fiscal Year 2008 NSF successfully demonstrated significant achievement of its three strategic outcome goals, according to the independent evaluation by the external review panel, the Advisory Committee for GPRA Performance Assessment.

The value of external expert review has been affirmed in two studies by the National Research Council of the National Academies. In a 2001 report, the Committee on Science, Engineering, and Public Policy (COSEPUP) stated, "Because we do not know how to measure knowledge while it is being generated and when its practical use cannot be predicted, the best we can do is ask experts in the field—a process called *expert review*—to evaluate research regularly while it is in progress." In a 2008 report, a COSEPUP committee states, "EPA and other agencies should

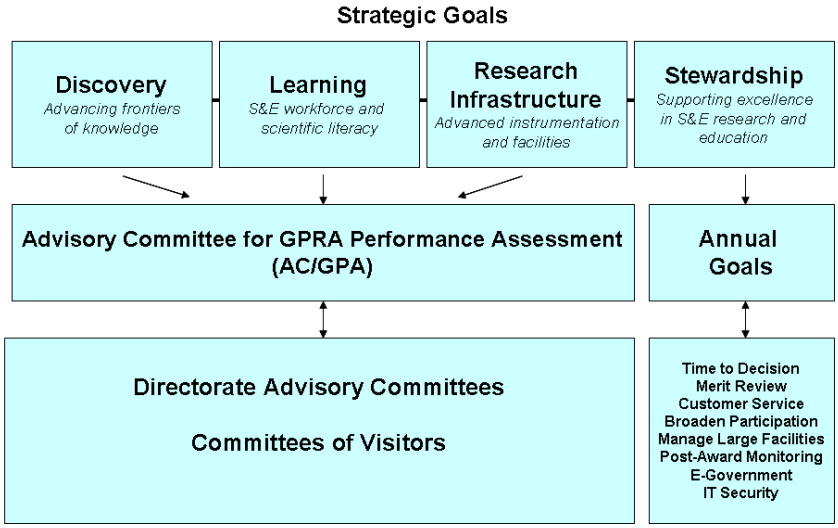
[4] Base obligation of $6.08 billion plus Trust Funds ($49 million), H1-B Nonimmigrant Petitioner Receipts ($121 million), and upward adjustments posted against expired authority in FY 2008 ($5 million) equals Direct Obligations Incurred as shown on the Statement of Budgetary Resources ($6.26 billion).
[5] The Fiscal Year 2008 AC/GPA report is available at www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08207.

use expert-review panels to evaluate the *investment efficiency* of research programs." COSEPUP adds that "*Investment efficiency* is used …to indicate whether an agency is 'doing the right research and doing it well.'"[6]

As shown in Figure 8, NSF uses a multi-layer assessment approach, integrating qualitative and quantitative performance goals. Central to performance assessment of agency-wide strategic goals is the Advisory Committee for GPRA Performance Assessment, which reviews outcomes on an annual basis. No less important, however, are the advisory committees for each of the Directorates and Offices, and the Committees of Visitors for each Division or crosscutting program, all of which provide independent advice on program management and conduct review of program outcomes. As noted above, the fourth strategic outcome goal, Stewardship, is focused on performance areas that are critical to the agency's efficient and effective operations and that also provide essential services to the science, engineering, and education community.

Figure 8.

NSF Performance Assessment Framework



Advisory Committee for GPRA Performance Assessment (AC/GPA)

The AC/GPA provides advice and recommendations to the NSF Director regarding NSF's performance under GPRA. NSF is the only federal agency that invites an external advisory committee to perform an analysis of its entire portfolio as part of the agency GPRA assessment process. Outcomes from basic research are unpredictable and difficult to quantify, with impacts often emerging many years after the research was conducted. Because GPRA requires agencies to report annually on progress toward achieving its goals, the AC/GPA conducts an annual review of reported outcomes.

The AC/GPA is comprised of about 20 members, each of whom has strong academic credentials and substantial experience in academia, government, and/or industry. About one-third of the members are also members of NSF Directorate or Office advisory committees, providing

[6] *Implementing the Government Performance and Results Act for Research: A Status Report* is available at www.nap.edu/catalog.php?record_id=10106 and *Evaluating Research Efficiency in the U.S. Environmental Protection Agency* is available at www.nap.edu/catalog.php?record_id=12150.

valuable linkages to those bodies. The Committee works closely with NSF staff during the three or four months prior to their annual meeting to ensure that they receive performance information for programs across the Foundation. The Committee is charged with reviewing NSF's investments in research and education to determine whether NSF demonstrated significant achievement in meeting its strategic outcome goals of Discovery, Learning, and Research Infrastructure. The Committee submits a report annually to the Director that evaluates NSF performance under each strategic goal. NSF's annual independent verification and validation report includes a review of the AC/GPA assessment process.

The AC/GPA uses evaluation criteria, or performance indicators, to evaluate outcomes from NSF's grant programs in research, education, and research infrastructure. The indicators take into account the support of potentially transformative research, stimulating innovation, developing successful models for teaching and learning, achieving active support of undergraduate and graduate students in research projects, and fostering research at large facilities or with advanced instrumentation that could not have been carried out without NSF support.

In its Fiscal Year 2008 Report, the AC/GPA concluded:

> **It is the unanimous judgment of the 2008 Advisory Committee for GPRA Performance Assessment (AC/GPA) that the National Science Foundation successfully met its performance objectives by demonstrating *significant achievement* for each of the three long-term, qualitative, strategic outcome goals in its 2006-2011 Strategic Plan.**[7]

The Committee recommended that, in the future, NSF take a longer view in assessing outcomes of research and education investments and find ways to track the careers of the people it supports. NSF is responding to those recommendations and will report back to the Committee at its June 2009 meeting.

Appendix A of this report contains the highlights selected by the Committee to represent outcomes reported in Fiscal Year 2008 from investments in *Discovery*, *Learning*, and *Research Infrastructure*. These highlights are only a small portion of the total number of highlights written by NSF program officers each year and many are based on annual and final project reports submitted by principal investigators. For more information, see http://www.nsf.gov/discoveries/

Advisory Committees and Committees of Visitors (COVs)

Advisory committees and Committees of Visitors (COVs) provide guidance on priorities and program effectiveness. Each division or crosscutting program has a Committee of Visitors (COV) that meets once every three years. Advisory committees are chartered by NSF and hence subject to Federal Advisory Committee Act (FACA) rules. COVs are subcommittees of advisory committees. COV recommendations must be addressed by NSF management, and appropriate actions are taken to comply. COVs also evaluate outcomes of NSF investments as they relate to NSF's strategic outcome goals. COV reports, along with the NSF responses to their recommendations, are submitted to the appropriate directorate or office advisory committee and to the Director of NSF. All COV reports and NSF responses are public documents posted at: www.nsf.gov/od/oia/activities/cov/covs.jsp.

[7] http://www.nsf.gov/pubs/2008/nsf08064/index.jsp

Assessing the Outcomes of Stewardship

Stewardship is defined in the NSF Strategic Plan as *supporting excellence in science and engineering research and education through a capable and responsive organization.* The performance areas focus on the agency's efficiency and effectiveness not only in its internal operations and management but also in delivering essential services to its constituents in the science, engineering, and education community.

In Fiscal Year 2008, NSF achieved 22 out of 23 milestones and measures associated with the eight performance areas under Stewardship:

Time to Decision	Management of Large Facilities
Merit Review	Post-Award Monitoring
Customer Service	E-Government
Broadening Participation	IT Security

Appendix B contains detailed results under these performance areas. Highlights of major accomplishments are:

Time to Decision (Proposal Dwell Time)

Every year since 2002, the Foundation has exceeded its "time to decision" goal of informing at least 70 percent of principal investigators of funding decisions within six months of receipt of the proposal. In Fiscal Year 2008, 78 percent of all proposals were processed within six months. This performance measure is aimed not only at the efficiency of the NSF staff but also at providing valuable service to the science and engineering community to keep them informed of the progress of their proposals. See Figure 3 on page 2.

Merit Review

Through intensive staff efforts, NSF revised the Committee of Visitors (COV) report instructions to provide more clarity and consistency in the COV examination of the merit review process. NSF also achieved its target that for 95 percent of proposals, a written context statement will be provided to the Principal Investigator that describes the process by which the proposal was reviewed and the context in which the decision to recommend funding or a declination was reached.

Customer Service

The Foundation improved access to NSF funding data by putting data on actions and awards on each Directorate home page, with specific data for each Division and an overall funding rate for the Directorate.

Broadening Participation

The Foundation published its portfolio of broadening participation programs on the NSF website (http://www.nsf.gov/od/broadeningparticipation/bp.jsp) and initiated the development of sophisticated, modern tools and capabilities to expand the pool of reviewers for NSF proposals.

NSF also introduced a standard orientation module for review panels that includes information on mitigation of implicit bias in the merit review process.

Management of Large Facilities

All of NSF's 19 large operational facilities met the goal of keeping operating time lost to less than 10 percent. The Foundation also completed Business System Reviews of the University-National Oceanographic Laboratory System (UNOLS) – Research Fleet, the Advanced Modular Incoherent Scatter Rader (AMISR), and the IceCube Neutrino Observatory.

Post-Award Monitoring

NSF completed all post-award tasks and financial monitoring through on-site visits and desk reviews according to the Foundation's risk-based identification model. NSF also completed all projected Federal Cash Transaction (FCTR) testing for the fiscal year.

E-Government

NSF delivered an initial release of Research.gov to the general public and grantee organizations. Research.gov offers a Policy Library, Research Headlines and Events, and Research Spending and Results information for NSF and NASA awards. The Foundation also completed all of its major E-Government implementation milestones.

IT Security

NSF successfully completed its Federal Information Security Management Act (FISMA) IT Program review, which ensured that 100 percent of the Foundation's major applications and general support systems are certified and accredited. In addition, 100 percent of NSF's IT systems are installed in accordance with security configurations and all have privacy impact assessments.

Summary of Program Assessment Rating Tool (PART) Results

All of NSF's programs have undergone PART review. Of the more than 1,000 PART programs that have been evaluated across federal agencies, 19 percent have received the highest rating of "Effective." Ten of NSF's eleven PART evaluations received an "Effective" rating, while the most recent evaluation of the K-12 Math and Science Education program received a rating of "Moderately Effective." NSF's PART evaluations are available on Expectmore.gov (http://www.whitehouse.gov/omb/expectmore/)

Each PART evaluation contains several long-term outcome measures as well as annual output and efficiency measures. When PART was introduced in 2003, NSF's PART evaluations were grouped into program categories that aligned with the agency's existing strategic plan. However, those program alignments did not carry over into the current strategic plan, adopted in 2006. As a result, some of NSF's PART performance measures were revised to align with the new plan. Please see Appendix C for detailed information on all of NSF's PART evaluations.

The figure below indicates how NSF's PART evaluations are aligned, in general, with the current strategic plan's outcome goals of *Discovery*, *Learning*, and *Research Infrastructure*.

Figure 9. **NSF PART Evaluations and NSF Strategic Outcome Goals**

PART Evaluation	**Strategic Outcome Goal**
Capability Enhancement of Researchers, Institutions and Small Businesses	Discovery Research Infrastructure
Fundamental Science and Engineering	Discovery
Science and Engineering Centers Programs	Discovery
K-12 Math and Science Education	Discovery; Learning
Support for Individual Researchers	Learning
Support for Research Institutions	Learning
Support for Small Research Collaborations	Learning
Construction and Operations of Research Facilities	Research Infrastructure
Federally Funded Research and Development	Research Infrastructure
Investment in Research Infrastructure and Instrumentation	Research Infrastructure
Polar Research Tools, Facilities and Logistics	Research Infrastructure

In Fiscal Year 2008, six of the 23 PART targets were not met. In Appendix C, explanations are given for each target not met, as well as improvement plans to achieve the targets in the future. The six PART targets not met were:

- the time-to-decision goal for NSF centers. This measures the time from receipt of a pre-proposal to the time when an invitation is issued to a prospective center to submit a full proposal (Science and Engineering Centers PART); page C-5;
- the percentage of proposals for education grants (submitted to the Directorate for Education and Human Resources, or EHR) from outside the top 100 institutions that NSF funds (Support for Small Research Collaborations PART and Support for Research Institutions PART); page C-7;
- the percentage of SBIR (Small Business Innovation Research) Program Phase I awards to new investigators (Capability Enhancement of Researchers, Institutions, and Small Businesses PART); page C-11;
- the percentage of non-academic partners for NSF centers. Non-academic partners include other government agencies, national laboratories, research museums, industry, schools, and research institutions in foreign countries (Science and Engineering Centers PART); page C-12;
- the number of graduate students funded through the Graduate Research Fellowship Program, the Integrative Graduate Education and Research Traineeship (IGERT) Program, and the Graduate Teaching Fellows in K-12 (GK-12) Program (Support for Individual Researchers PART); page C-13;
- the schedule variance for one of NSF's major multi-user facilities, the Scientific Ocean Drilling Vessel (Construction and Operations of Research Facilities PART); page C-14.

Types and Sources of Performance Data and Information

Most of the information that informs the external expert review and assessment of outcomes under the strategic outcome goals originate outside the agency and are submitted to NSF by principal investigators through the Project Reporting System, which includes annual and final project reports for all awards. Through this system, performance information and data are available to program staff, third party evaluators, and other external committees.

Examples of types of information and data are:

- Information on *Discovery:* Published and disseminated results, including journal publications, books, software, audio or video products; contributions within and across disciplines; organizations of participants and collaborators (including collaborations with industry); contributions to other disciplines, infrastructure, and beyond science and engineering; use beyond the research group of specific products, instruments, and equipment resulting from NSF awards; and role of NSF-sponsored activities in stimulating innovation and policy development.

- Information on *Learning:* Student, teacher, and faculty participants in NSF activities; demographics of participants; descriptions of student involvement; education and outreach activities under grants; demographics of science and engineering students and workforce; numbers and quality of educational models, products and practices used/developed; number and quality of teachers trained; and student outcomes including enrollments in mathematics and science courses, retention, achievement, and science and mathematics degrees received.

- Information on *Research Infrastructure:* Published and disseminated results; new tools and technologies; multidisciplinary databases; software, newly-developed instrumentation and other inventions; data, samples, specimens, germ lines, and related products of awards placed in shared repositories; facilities construction and upgrade costs and schedules; and operating efficiency of major multi-user facilities.

Most of the data supporting the annual quantitative performance goals may be found in NSF's central systems. These central systems include the Enterprise Information System; FastLane, with its Project Reporting System and its Facilities Performance Reporting System; the Program Information Management System (PIMS); the Proposal and Reviewer System; the Awards System; the Electronic Jacket; and the Financial Accounting System. These systems are subject to regular checks for accuracy and reliability.

Data/Information Limitations

In its annual review, the AC/GPA examines recent Committee of Visitor reports and program assessments conducted by external expert panels, principal investigator project reports, and award abstracts. Because it is impractical for an external committee to review the contributions to the performance goals by each of the more than 20,000 active awards, NSF program officers provide the Committee with summaries of notable results each fiscal year. These summaries of results, or "highlights," from awards, are a primary source for the AC/GPA determination of whether NSF demonstrated significant achievement in the strategic outcome goals of *Discovery, Learning,* and *Research Infrastructure*. The approach to highlights collection is a type of non-probabilistic sampling, commonly referred to as "judgmental" or "purposeful" sampling, which is best designed to identify notable examples and outcomes resulting from NSF's investments. It is the

aggregate of collections of notable examples and outcomes that can, on their own, demonstrate significant agency-wide achievement of the strategic goals. Nevertheless, taken together, the highlights, COV reports, project reports, award abstracts, and other reports of notable accomplishments covers the entire NSF portfolio.

Data Verification and Validation

As in prior years, NSF engaged an independent, external consultant to conduct a validation and verification (V&V) review of its annual performance information and data. IBM Global Business Services (IBM) completed a V&V review of the performance data and information reported for all the FY 2008 goals except three *Stewardship* goals: Post-Award Monitoring, E-Government, and IT Security. These three goals were examined as part of NSF's Internal Controls review and it was determined that a second review by IBM would be redundant.

For the strategic outcome goals, IBM reviewed the processes NSF used to obtain external assessment of its goals. IBM's V&V review is based on guidelines issued by GAO that require federal agencies to provide confidence that the policies and procedures underlying performance reporting are complete, accurate, and consistent. (See *GAO Guide to Assessing Agency Annual Performance Plans*, GAO/GGD-10.1.20.) IBM assessed the validity of the data and reported results as well as verified the reliability of the methods used to collect, process, maintain, and report data. IBM also reviewed NSF's information systems based on GAO standards for application controls. The FY 2008 Performance Measurement Verification and Validation Report, dated October 22, 2008, concludes:

> "Based on this verification and validation (V&V) review, we were able to verify the reliability of the processes and validate the accuracy of 23 of 24 annual performance goals. Due to unreported results, we were unable to verify and validate the remaining performance goal. In addition, we were able to verify and validate the reliability of the assessment processes for NSF's three Strategic Outcome Goals.
>
> Overall, we verify that NSF relies on sound business practices, internal controls, and manual checks of system queries to ensure accurate performance reporting. NSF maintains adequate documentation of its processes and data to allow for an effective V&V review. Based on this comprehensive review, IBM has confidence in the systems, policies, and procedures used by NSF to generate results for the described performance measures. NSF continues to take concerted steps to improve the quality of their systems and data. We commend NSF for this effort to confirm the reliability of its GPRA data and results, and the quality of its processes for collecting, processing, maintaining, and reporting data for its performance goals."[8]

[8] IBM Global Business Services. *National Science Foundation Government Performance and Results Act and Program Assessment Rating Tool: Fiscal Year 2008 – Performance Measurement Verification and Validation Report.* October 22, 2008.

Additional Information

Program Evaluations

See Appendix D for information on program evaluations.

Information on Use of Non-Federal Parties

The NSF Annual Performance report was prepared solely by NSF staff. External, non-federal sources of information used in preparing the report include:

- Reports from awardees demonstrating results
- Reports prepared by Committees of Visitors assessing NSF programs
- Reports prepared by an external, independent management consulting firm to validate and verity the procedures used to collect, process, maintain, and report performance goals. In Fiscal Year 2008 that firm was IBM Global Business Services.
- Reports from facilities managers on construction cost and schedules and operations.

Classified Appendixes not Available to the Public

None

APPENDIX A: Results of Strategic Outcome Goals

Program Highlights from the Fiscal Year 2008 Report of the Advisory Committee for GPRA Performance Assessment: *Discovery, Learning,* and *Research Infrastructure*[9]

Discovery

The Advisory Committee for GPRA Performance Assessment (AC/GPA) concluded on the basis of the highlights analyzed, that NSF has demonstrated significant achievement in meeting its goals in the area of Discovery. The 260 program highlights that were reviewed clearly demonstrate that NSF "fosters research that advances the frontiers of knowledge and helps in establishing our nation as a global leader in fundamental and transformational science and engineering." The Committee selected the following highlights as examples of significant achievements in the area of Discovery:

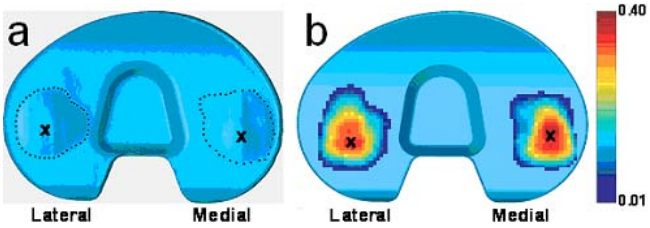
- ***Strengthen fundamental research across the full spectrum of science and engineering through support for NSF's fundamental or core disciplinary programs.***

It has been the conventional scientific wisdom for almost a century that magnetism in a given material opposes conventional superconductivity, such as that found in pure metals. Nobel laureates J. Bardeen, L.N. Cooper, and J.R. Schriefer showed that when superconductivity occurs the electrons in the metal form pairs. However, in unconventional superconductors, such as high temperature ones, where materials are on the verge of being magnetic, the electrons causing superconductivity take a different collective form than those in conventional superconductors, but the superconducting mechanism is not yet understood. A project titled **Magnetism Meets Superconductivity** *(Highlight 15821; Award Number 0710492)* is a collaborative effort between Zachary Fisk's group at University of California, Irvine and investigators at Los Alamos National Laboratory and Dresden University in Germany, and explores the boundary between superconductivity and magnetism. In crystals of one of these unconventional superconducting materials, consisting of a combination of cerium, cobalt, and indium, both superconductivity and magnetism have been discovered to coexist. This research is an example of fundamental and transformative research that could lead to a completely new understanding of the mechanisms causing superconductivity in high-temperature superconducting materials. $CeCoIn_5$, discovered in this NSF-funded research, has proven to be an ideal material for studying physics at the magnetic/superconducting boundary. These revolutionary findings are a direct result of support for Dr. Fisk that began with NSF-DMR 7504019, when he was a beginning investigator. Long-term NSF support of his research on fundamental condensed-matter physics has led to exciting, important results and to the field of highly correlated electron systems. This result could benefit many electrical applications areas such as power transmission and electronics.

Two other projects that "strengthen fundamental research across the full spectrum of science and engineering" are CAREER (Faculty Early Career Development Program) Awards. Program officers who highlighted these projects indicated that the projects were not only transformative in nature, but also promoted broadening participation, and had societal benefits as well. The first of these projects is titled: **The High Fidelity of Human Image Representation** *(Highlight 16657, Award Number 0546262)*. Dr. Aude Oliva and her team in the Department of Brain and

[9] The *Report of the Advisory Committee for GPRA Performance Assessment, FY 2008* is available at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08064.

Cognitive Sciences at MIT are currently exploring a novel avenue to explain the feat of human visual understanding, testing human capacity at remembering visual details for a given image. Her work has demonstrated that human visual memory can encode a massive amount of visual details that is an order of magnitude higher than previously believed. These results challenge assumptions about efficient image representations, which is highly relevant to cognitive psychology, neuroscience, and computer vision. This study potentially could lead to much higher-performance artificial vision systems as well as better understanding of human visual processes, which have potential applications to consumer technologies and homeland security and defense. The project affords significant opportunity to examine the ethical and safety dimensions of new technologies that may emerge.



The second CAREER Award selected for this criterion is titled: **Virtual Prototyping of Artificial Knees** *(Highlight 16684, Award Number 0239042)*. Dr. Benjamin Fregly, University of Florida, and his team are addressing a growing need for the aging American population. By one estimate, 40 million Americans will be affected by osteoarthritis in the year 2020. It is felt that this project could lead to an entirely new approach for designing knee replacements, and testing innovative designs using computer software rather than physical simulator machines. This work is unique because of its ability to predict long-term wear characteristics of knee replacement designs in a matter of minutes or hours using computer simulations. In terms of Broader Impacts, high school students from underrepresented groups have been involved in the knee research, through the University of Florida Summer Science Training Program. In addition, an orthopedic implant company has already enlisted the research team to participate in design of the next generation of knee replacements. Significant ethical and safety issues implicit in this study are ripe for further examination.

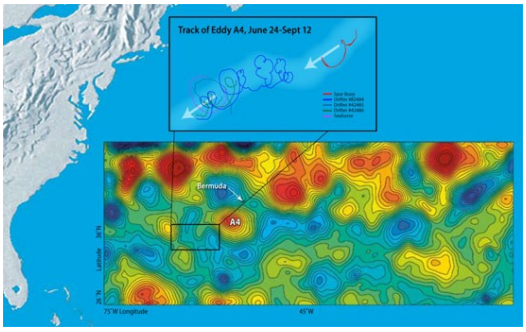
Cross-fertilization of ideas between disciplines can be transformative. Using control theory techniques originally developed for engineering applications, engineers are helping to transform medical treatment of cancer. The project **Control in Genetic Regulatory Networks: An Engineering Approach to Increase the Success Rate in Cancer Therapy** *(Highlight 15041, Award 0355227)* uses control theory from engineering to formulate the process of moving a cell from a diseased state to a disease-free state. The genetic regulatory networks were constructed from experimental data provided by collaborating biologists. The objective was to reduce the activity of certain genes at the tissue level by partitioning the probable outcomes of treatment strategies into good and bad regimes. The theoretically developed control algorithms performed significantly better in simulation studies than alternative approaches currently used. The project strengthens fundamental research in genomics using engineering analysis techniques of signal processing and control, and fosters discoveries whereby an engineering approach may transform medicine. In addition, this work promoted sufficient innovation to win a major follow-up grant from the W. M. Keck Foundation for validation experiments. Finally, it addresses the Strategic Plan goal of investigating the human and social dimensions of new knowledge and technology by transforming medical treatments in cancer.

- ***Foster discoveries that have the potential to transform disciplines or fields of science, engineering, or education research.***

Given the increasing frequency of tornadoes experienced today, new technologies to predict when and where tornadoes and other weather disturbances (floods, severe thunderstorms) will occur are

of obvious importance. The NSF Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere (CASA), located at the University of Massachusetts at Amherst, has developed a method of weather sensing that utilizes dense, low-cost radar networks that can sense the lower atmosphere, an important area that is under-sampled by today's technologies *(***New Radar Network Evaluated in National Weather Service Experimental Warning Program**, *Highlight 15599, Award 0313747)*. The finely grained observations of the lower atmosphere obtained by the CASA researchers allowed forecasters to see small meteorological structures that are close to the ground, such as mini-wind clusters that are embedded in larger storms. During the 2007 tornado season, CASA transmitted real-time data from its first prototype network in Oklahoma to National Weather Service forecasters for evaluation in the Experimental Warning Program. The Center's data will continue to be evaluated in the Experimental Warning Program during the 2008 tornado season. This research is multidisciplinary, requires a complex-systems approach, and involves collaboration between various universities and government agencies at many levels. The research is transformative because it will introduce a new dimension to weather forecasting and sensing, yielding capabilities that do not exist today. This highlight also represents broadening participation in that the faculty and students involved include many women and members of underrepresented minorities.

Interactions Between the Wind and Oceanic Eddies Stimulate Higher Biological Productivity In Subtropical Ocean Surface Waters *(Highlight 16578, Awards 0241310, 0241340, 0241023)* is a project led by Dr. Dennis McGillicuddy, Woods Hole Oceanographic Institution, with a team of collaborative investigators from eight different institutions. Oceanographers from these institutions have sampled two different types of eddies over a period of months using a sophisticated approach employing high-tech instrumentation to measure horizontal and vertical dispersion of several water properties. This research contributes to the fundamental knowledge about what factors control biogeochemical cycles and the conversion of carbon dioxide into biomass in the oceans. Their work has demonstrated that episodic eddy-driven upwelling may supply a significant fraction of the nutrients required to sustain primary productivity in the subtropical ocean. The results from this study are changing the view of how biological production and export of carbon to the deep ocean is taking place in the mid-ocean.

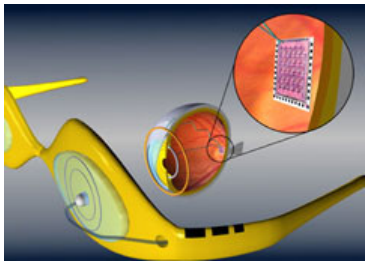


Fundamental research at the atomic level is still alive and well, and established wisdom continues to be challenged. A striking example of this is the preparation of "ultra-heavy" isotopes, magnesium-40 (normally Mg-24), aluminum-42, and aluminum-43 (normally Al-27). These extraordinarily heavy isotopes, created at the National Superconducting Cyclotron Laboratory at Michigan State University *(***Newly Created Forms of Magnesium and Oxygen**, *Highlight 16189, Award 0606007)*, defy established theory, which predicts that they should not be stable. The results emerged from careful detection with enhanced techniques that allowed observation of one in one billion particles, an experiment that could not have been carried out without a user facility of this unique type.

A project, **Beware What's Unaware: Deep Impact of Subtle Distractions**, undertaken by Takeo Watanabe, a cognitive neuroscientist at Boston University *(Highlight 15885, Award 0549036),* fosters discovery into the mechanisms of attention disorders by demonstrating how different regions of the brain interact. He found that participants had more difficulty suppressing subliminal, low-coherence stimuli (randomly moving dots on a computer screen) when trying to focus on a particular task. This was demonstrated by imaging a particular area of the brain, Middle Temporal, (MT), which perceives motion. The project also simultaneously imaged another area of the brain, the dorsolateral prefrontal cortex (DLPFC), which is responsible for inhibiting responses in the MT. They found that the DLPFC area did not activate when presented with low-coherence stimuli, thereby causing activity in the MT area. They also showed more activity in the MT area with low-coherence stimuli than with high-coherence (coordinated) stimuli. This project has implications for understanding attention disorders in humans (as this research shows that subtler distractions are harder for the brain to screen out) as well as understanding how different regions of the brain interact. It may result in more efficient workplace design. This meets the evaluation criteria of strengthening fundamental research (in understanding better how different regions of the brain interact) and fostering discoveries that could transform cognitive research on attention disorders. Finally, it addresses the Strategic Plan goal of investigating the human and social dimensions of new knowledge and technology.

- ***Promote innovation and partnerships with industries to stimulate the development of new technologies and processes to further U.S. economic competitiveness and benefit the Nation.***

More than 25 million people around the globe, including six million in the United States, are visually affected by genetic retinal diseases. Researchers are working to help patients blinded by Retinitis Pigmentosa; the work involves development of a second generation prosthetic implant (ARGUS II) that will enhance the vision of individuals who have lost sight *(***USC Research May Help Patients Blinded by Retinitis Pigmentosa**, *Highlight 15664; Award 0310723).* The new implant was developed by Dr. Mark Humayun's research team at the University of Southern California and Second Sight Medical Products Inc. The ARGUS II consists of a tiny camera and transmitter mounted on eyeglasses, an implanted receiver, and an electrode-studded array that is secured to the retina with a microstack the width of a human hair. A wireless microprocessor and battery pack powers the entire device. Six patients were implanted with earlier prototypes in 2002, and can now perceive light, distinguish between objects, and detect motion. The new implant contains nearly four times as many electrodes as the original (60 vs. 16), each of which is independently controllable, allowing patients to process higher-resolution images. Researchers hope the ARGUS II will be available in a few years and are currently enrolling subjects in clinical trials.



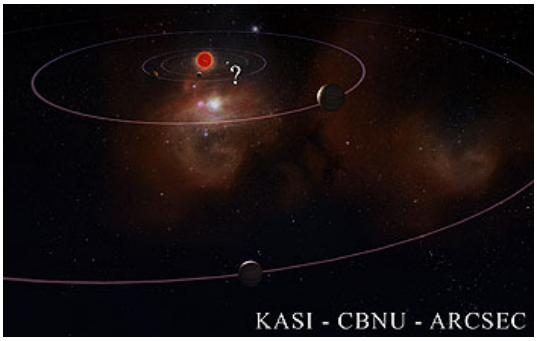
This work is transformational in that it represents breakthroughs in microelectronics, image processing, and bio-engineering, which are likely to lead to radically new prosthetic technologies in other areas beside the retina. By 2020, some 50 million patients who have lost their sight due to genetic eye diseases that affect the retina are projected possibly to be able to regain some of their sight using a new retinal implant. The research also satisfies the NSF Strategic Plan's emphasis on broadening participation in that a number of key members of the research team are women. Finally, it demonstrates one of the investment priorities of the Strategic Plan goal of investigating human and social dimensions of new knowledge and technology by developing products to give some level of sight to patients suffering from Retinitis Pigmentosa.

Bendable Concrete for Safe, Durable, and Sustainable Infrastructure *(Highlight 15376, Awards 0223971, 0329416, 0700219)* is a project by investigators at the University of Michigan who have designed a new type of concrete that maintains all the advantages of current concrete but adds ductility, allowing it to bend under stress without fracture. The new type of concrete has 300-500 times the tensile ductility of normal concrete; it can be bent without fracturing when overloaded. The material also exhibits self-healing properties, which further enhances its durability. The work may establish the United States as the global leader in "designer" cement-based composites. It also embodies collaboration among several sectors: government, industry, and academic partners. It has potential consequences in the design of sustainable structures resistant to earthquakes and weather events. This research also exemplifies the NSF Strategic Plan goal of integrating research on ethics, and safety considerations.

- ***Promote international collaboration among U.S. investigators and partners in other countries and regions.***

Research and Education Experiences for Students to Examine Earthquake Hazard Mitigation Utilizing the Network for Earthquake Engineering Simulation (NEES) is an excellent example of international collaboration *(Highlight 16728, Award 0526590).* Professor Richard Christenson and graduate and undergraduate students traveled to Thailand and Japan to conduct research in innovative ways to reduce structural damage arising from natural hazards, such as earthquakes. The visits and collaborative research in the two countries are enabling partnership building between United States, Thai, and Japanese institutions, and scientists who are engaged in the study of ways to create better designed buildings that can withstand strong forces during earthquakes and tsunamis, thus enhancing public safety.

The societal urgency of understanding impacts of global warming on sea level rise requires establishment of innovative observations and partnerships. In the project, **Sea Level Rise from Polar Ice Sheets: Societal Relevance and Broader Impacts** *(Highlight 14730, Awards 0122520, 0407827, 0424589)*, the Center for Remote Sensing of Ice Sheets (CReSIS) serves to join forces between U.S. universities (U. Kansas, Ohio State, Penn State, U. Maine, Elizabeth City State University, and Haskell Indian Nations University) and international collaborators from Denmark, Norway, Australia, the United Kingdom, and Iceland, and the Topeka K-12 school district. This team is transforming science and engineering fields by using satellite-based sensing of the earth with UAV (Unmanned Aerial Vehicle) and traditional airborne-based radar, along with seismic and other measurements with data products, modeling, and analysis to improve on current estimates of sea level rise resulting from global warming. The Nobel-Prize-winning IPCC (Intergovernmental Panel on Climate Change) 2007 estimates, which may under-predict the rate of future sea level rise, are based on traditional modeling of the ice sheets, which ignore rapid changes that may occur due to recently observed mechanisms of bed lubrication and ice shelf stability effects. CReSIS is integrating discovery and learning via classroom activities developed for K-12 education, which are free and available to all via their website (https://www.cresis.ku.edu/), along with the Summer School for Teachers and PolarTrec, which increase classroom knowledge of climate change. This project has genuine partnerships with minority-serving institutions, which play integral roles in the discoveries and reporting of results. Finally, this work investigates human and social dimensions of new knowledge and technology by integrating discovery (better modeling of sea level rise due to the integration of various observations and data sets) and learning using K-12 classroom activities.



Going from the subatomic to the cosmological, astronomers collaborating from 11 universities have observed a new solar system analogous to ours but smaller in size that contains planets similar to Jupiter and Saturn (**Newly Found Solar System has Jupiter/Saturn Pair Similar to Ours, just scaled down**, *Highlight 16275, Awards 0206189, 0452758, 0708890)*. The system was detected by "gravitational microlensing," in which light from another star is magnified by the passing of another body—in this case, the star detected—in front of it. Observations from the 11 different ground-based telescopes provided the sensitivity to observe the planets. The small size of the solar system compared to other exosystems suggests that solar systems like ours may not be rare. The work is an excellent example of an international collaboration, including participation of amateur astronomers.

Research stimulated by the devastation caused by tsunamis has revealed possible origins for their profound impact. Japanese and U.S. scientists *(***"Ultrasound" of Earth's Crust Reveals Inner Workings of a Tsunami Factory**, *Highlight 16358, Award 0451790)* examining the seafloor near the southwest coast of Japan, where tsunamis are particularly prevalent, have found a major fault line that can trigger serious earthquakes, which are known to occur in that region. Core drilling also reveals that the fault line appears to have shifted landward over time, and has become shallower and steeper, conditions that are ideal for tsunamis. These multidisciplinary results, carried out through an international partnership, contribute to developing ways for living sustainably on Earth.

Learning

The Advisory Committee for GPRA Performance Assessment (AC/GPA) concluded on the basis of the highlights analyzed, that NSF has demonstrated significant achievement in meeting its goals in the area of Learning. The 159 program highlights that were reviewed clearly demonstrate that NSF "cultivates a world-class, broadly inclusive science and engineering workforce, and expands the scientific literacy of all citizens." The Committee selected the following highlights as examples of significant achievements in the area of Learning.

A significant number of projects contributed to creating a pre-school to postdoctoral STEM pathway that engages learners across all levels of schooling, involving learners in hands-on science, broadening participation, and increasing scientific literacy across age groups and backgrounds. Two examples are particularly telling of the cross-cutting nature of some of the initiatives in the portfolio.

Vast Facility in Appalachia Brings Students, Researchers Together (*Highlight ID 16111, Award 0520928)* describes a facility in Appalachia that studies cosmic ray sources. The project engages high school and college students in scientific research and outreach activities to members of the community. The location of the facility is unique, providing first-time access to advanced instrumentation for populations without a robust tradition of scientific research: students are given opportunities to make genuine and exciting discoveries. In sum, this project integrates successfully education, research, and societal benefit.

Another example is given in **New Flight Simulator Environment Engages Students in Interdisciplinary Research at Historic Tuskegee University** (*Highlight ID 15039, Award 0411464*), which describes a multidisciplinary, collaborative effort at Tuskegee Institute. The Flight Simulator Environment brings together aerospace engineers and psychologists in a quest to understand ways in which pilots make decisions during flight. Research on the topic was conducted by twelve Tuskegee students, and their work has great potential for societal impact, especially in the area of public safety.

In addition to these all-encompassing examples of excellence, the Subgroup also has identified projects that speak specifically to K-12 education, undergraduate education through postdoctoral level, and public understanding of STEM and lifelong learning.

K-12 Education

The portfolio of highlights provides many examples of work that engages learners across all levels of schooling and prepares K-12 teachers to create and deliver meaningful STEM curricula. The enrichment of K-12 students through research experiences is an important theme found in the highlights. The work summarized in **Scientists and Students Online: An Oceanographic Expedition to the Indian Ocean** (*Highlight ID 16357,* Award 0652315) exemplifies integration of pre-college students in a cutting edge research project through real-time tracking of an oceanographic expedition to the Indian Ocean. This ingenious use of the web resulted in increasing numbers of students tracking and participating in learning activities connected with the expedition. **COSMOS Students Become Rocket Scientists** (*Highlight ID 16417, Award 0602286*) describes a summer residential program at the University of California, San Diego (UCSD) that brings together high school students, undergraduates, graduate students, postdoctoral fellows, and faculty at UCSD with a focus on rockets.

The development of teachers is also an important feature of the portfolio. A Robert Noyce Scholarship program summarized in **Noyce Scholars Prepared to Teach in High-Need Schools** (*Highlight ID 14873, Awards 9852170, 0733849*) addresses the need to attract and retain the next generation of STEM professionals. The program has recruited 63 new math and science teachers to teach in high-need school districts in California, and 65 percent of the scholars have been drawn from underrepresented populations. In another similar example, **Vanderbilt University Biomedical Engineering Research Experience for Teachers** (*Highlight ID 15384, Award 0338092*), 44 teachers participated in a 24-day summer program with academic year follow-up. They completed a research project in a biomedical engineering laboratory, designed instructional units based on that research experience, and implemented them in their high school classrooms.

Project SEEDBed (**Stimulating Enthusiasm, Exploration, and Discovery through Biotechnology Education),** *(Highlight ID 14893, Award 0602744*) engages students and teachers from middle and high schools in summer academies at community colleges designed to increase knowledge, stimulate interest in biotechnology among students and teachers, and encourage students to pursue further study, possibly leading to careers as biotechnicians. Teachers are provided with "footlockers" to take back to their classrooms, with all of the equipment necessary to conduct

new laboratory activities. Evaluation data indicate significant impact on both students and teachers.

In the project described in **Bringing an Atomic Force Microscope to School** (*Highlight ID 16213, Award 0653346*) high school teachers learn science through serious engagement with University of Wisconsin-Milwaukee faculty, with the science of CD-ROMs and DVDs as the focus. The effective and exciting use of technology in instruction is accomplished through classroom visits by UWM faculty who bring an Atomic Force Microscope to high schools as part of their instruction on the inner workings of CD-ROMs and DVDs. Broadening participation occurs through involvement of high school teachers.

A number of highlights summarize important work that teaches science in cultural context. **BPC-DP: New Voices and New Visions for Engaging Native Americans in Computer Science** (*Highlight ID 16501, Awards 0539982, 0540484*) describes a highly innovative pilot project that integrates Native American culture and experience with computer science. High school and college level students use computing to illustrate and display Native American art and culture to wider publics. By using the computer in culturally affirming ways, students are attracted to computer science and hopefully STEM work in general. The project should result in increasing the participation of Native Americans in computer science. It also illustrates the effective use of the computational sciences as a window for learning about arts and culture, as well as the use of arts and culture as a vehicle for attracting students to computer science. The project, if successful, should be highly replicable across regions and cultures.

WolfQuest: Learning Science through Game Play (*Highlight ID 15717, Award 0610427*) is a project that brings wolf behavior and ecology to life through exciting game play and intense social interactions for youth who are not normally attentive to ecological concepts and conservation issues. The WolfQuest game (www.wolfquest.com) represents a new model for informal science learning with practical, cultural, and ethical values embedded in the game's design. With an engaging online forum for learner-generated content, including art, stories, photos, and videos, WolfQuest has created a safe and engaging arena for youth. Removing the formal barriers typically found between scientists and the public, youth can talk directly with the world's leading wolf researchers as scientist role models. Striving to create new forms of science learning, in WolfQuest learners must engage experientially in authentic scientific problem solving using their reasoning skills to figure out complex scenarios regarding wolves and wolf survival without any external guidance. Because of its unique learning strategies, WolfQuest will aggregate data on learners' science content acquisition, attitudinal change, game engagement, and will ultimately yield new guidelines on effective practices for the future development of science education games and appropriate methodologies for evaluating game-based learning.

Undergraduate Education through Postdoctoral Level

A number of highlights described alternative pedagogical approaches to undergraduate science education. For example, a project summarized in **From Sausages to Skateboards** (*Highlight ID 15221, Award 0431756*), measured the impact of teaching real-life applications in undergraduate mechanical engineering courses. The research demonstrated that the use of applications had a

positive impact on final course grades only when the whole course was applications based. Students in the application-based course had significantly higher final course grades than comparison students matched by instructor and course who did not receive application-based teaching or when only two or three applications were used during a course.

In a similar vein, **An Infrastructure for Designing and Conducting Remote Laboratories** *(Highlight ID 16031, Award 0326309*), describes a project consisting of an online laboratory environment that supports experiments based on multi-player computer game engines. This project aims to conceive, design, implement, test, and assess various online laboratory resources for undergraduate engineering and science education based on the use of advanced information technologies and of the rapidly expanding cyberinfrastructure. These online laboratory resources include remote experiments, virtual experiments, and virtual learning environments. Cyberinfrastructure-enabled educational tools such as this online laboratory environment show strong potential for initiating a dramatic shift in the general educational paradigm where the interactions between learners and educational resources as well as between

The portfolio has many examples of programs aimed at populations of students currently underrepresented in STEM disciplines (*Highlight IDs 14876, 15287, 15299, 15304, 15345, 15350, and 15389*). However insufficient data are provided to assess fully the outcomes and broader impacts of these initiatives. That having been said, some examples do stand out. A program at a university in Texas (**Undergraduates Discover the Thrill of Research**, *Highlight ID 15007, Award 0344221*) emphasized learning through discovery rather than by development of specific technical skills. The approach demonstrated success with inquiry-based exposure to scientific research, and the pilot group of 16 students won first place in a college-wide competition. In addition, two students from the group received awards for research presentations at the Louis Stokes Alliances for Minority Participation Program. Likewise, **Flying High in Louisiana** (*Highlight ID 16198, Award 0653423*), describes a curriculum revolving around small balloon science experiments and flight. These activities are designed to attract students from underrepresented groups into STEM programs and develop partnerships between Louisiana State University and local minority serving institutions. The students develop and conduct science experiments involving physics and thermodynamics. They create, launch, and bring to earth balloon vehicles. The project involves minority youth in creative experiments, exposing them to physics and the process of scientific research.

Project Pathways (**Community College Students Discover Rare Mushroom in Texas**, *Highlight ID 15403, Award 0525536*) is a community college research project that has increased the number of students who obtained associate degrees or transferred to baccalaureate programs in science, technology, engineering, and mathematics (STEM) disciplines. Eastfield College students participate in research projects with various agencies. Some students were placed with U.S. National Park Service researchers and others in collecting data for the All Taxa Biodiversity Inventory of the Big Thicket. These data are used for national strategic planning related to a host of environmental issues. Additionally, the students collect data for their own research projects in biological areas of their choosing including botany, entomology, mycology, and ichthyology. The expedition to the Big Thicket enabled genuine scientific discoveries by students at the community college. Eastfield College is primarily a Hispanic serving institution. The students participating in Project Pathways are mostly first generation college students, women, African-

American, Hispanic, or students with disabilities. The program often provides these students with critical first experiences in STEM. This project also illustrates how community colleges enhance infrastructure with major scientific instrumentation to integrate research and innovative teaching that advances discovery and scientific understanding for early undergraduates.

A very good model for global engagement of STEM students is NanoJapan (**Rice University PIRE Program Feated as Best Practice in International Education**, *Highlight ID 15598*, *Award 0530220*), a program of 12-week research internships in Japan for undergraduate engineering majors that has been awarded the 2008 Andrew Heiskell award for innovation in study abroad by the Institute for International Education. The NanoJapan program sends a diverse group of sixteen first and second year engineering majors from U.S. universities to leading edge nanotechnology laboratories throughout Japan to work with Japanese teams on research projects related to carbon nanotube fabrication. NanoJapan serves as a model for increasing study abroad and for participation of students in science and engineering fields. NanoJapan allows students to gain both experiences. Internships with world-class researchers in state-of-the-art facilities allow students to enhance engineering and research skills while building the cultural understanding, adaptability, and networks necessary to succeed in the global marketplace. This program has strong potential benefits in workforce development. In addition, the exposure of budding engineers to world-class nanotechnology expertise and facilities in Japan can be expected to enhance research and industrial engineering in the United States as participants advance in their careers.

Also noteworthy are the Pan American Advanced Studies Institutes (PASIs), which are jointly funded by the Department of Energy and the NSF (**Better (and More Sustainable) Living with Green Chemistry**, *Highlight ID 15261*, *Awards 0221274*, *0617357*). A Sustainability and Green Chemistry PASI, organized by Dr. Mary Kirchoff of the American Chemical Society, was held in Mexico City, Mexico. Fifty-five graduate and postdoctoral students, nine local participants, and fourteen faculty members representing chemistry, pharmacy, biotechnology, packaging, genetics, nanotechnology, and chemical, civil, environmental, and geo-environmental engineering participated in interdisciplinary activities and research to advance their knowledge of green chemistry and green engineering. Participants received educational materials and project ideas that could be implemented at their home university and within their local community. This project is an exemplar of interagency collaboration, global engagement, broadening science and engineering knowledge for sustaining the earth, and education extending to the postdoctoral level.

Public Understanding of STEM and Lifelong Learning

The portfolio is rich in examples of projects that enhance public understanding of science and engineering. Here we focus on three particularly innovative programs that cut across age groups. CYBERCHASE (**NSF-Funded CYBERCHASE Wins Emmy,** *Highlight ID 14955*, *Award 0638962*) is a ground-breaking multi-platform children's program on PBS KIDS GO! that shows the connection between mathematics and the invention process. The content spans the 3rd-5th grade standards of the National Council of Mathematics. The program has been awarded a daytime Emmy and reaches nearly five million viewers each week. It has recorded more than 1.7 billion page views for CYBERCHASE Online (http://pbskids.org/cyberchase/). Importantly, research shows that viewers take away the mathematics content of the episodes they watch and visitors spend more than an hour at the site on the average visit.

The Coalition on the Public Understanding of Science – COPUS (*Highlight ID 15556, Award 0628790*) is organizing the Year of Science 2009, a national year-long celebration of science to engage the public in science and improve public understanding about the nature and processes of science. COPUS is a growing network with over 180 registered participants that include professional societies, government agencies, business, universities, museums and informal science centers representing all major science disciplines. The network has an active website with information about the organization, national events, resources, and new participant registration. The database allows the public to search for COPUS related activities based on type, location, discipline, and target audience. To better coordinate COPUS activities, the network participants are organizing in regional and thematic hubs that will facilitate the interaction among network participants with common goals.

sLowlife: A Traveling Exhibit of Plant Science and Art (*Highlight ID 15586, Awards 0080783, 0416741, 0531641*) is a novel multi-media educational/art installation including video, live plants, photographic prints, and interactive environments, originally designed by plant biologist Dr. Roger Hangarter in collaboration with an artist, Dennis Dehart. The exhibit highlights the research of Dr. Hangarter and is designed to convey to a public audience that plants are complex living beings and not just the ornamental inanimate objects many people assume. By combining time-lapse movies with artistic elements that demonstrate various plant movements and growth responses, the exhibit accurately and effectively combines science and art in a way that provides scientists and non-scientists with a novel way of learning some basic plant biology and an appreciation of the dynamics of plant growth and movement. Contemporary research approaches, including a striking presentation of a genetic screen for tropism mutants in Arabidopsis, use of microarrays to understand plant growth, use of green fluorescent protein (GFP) to visualize the cytoskeleton, and views of chloroplast movement are mixed with classic experimental and educational demonstrations. With written commentary kept to a minimum, the visual impact of plants and experimental data dominates the experience in this novel exhibit.

Research Infrastructure

The Advisory Committee for GPRA Performance Assessment (AC/GPA) concluded on the basis of the highlights analyzed, that NSF has demonstrated significant achievement in meeting its goals in the area of Research Infrastructure. The 115 program highlights that were reviewed clearly demonstrate that NSF "builds the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools."

Research Infrastructure encompasses the entire scope and scale of science, mathematics, technology, and education, enabling the conduct of leading-edge research while educating the next generation and future generations of scientists and engineers. Imagine funding the discovery and development of probes that can detect the most singularly quantifiable constituents of the nucleus of an atom or production of an educational video that describes the "life" of a single electron that travels around any nucleus. Research infrastructure has evolved to a point where scientists and engineers can develop and use instrumentation and probes to study phenomena that are smaller than a single strand of hair. At the other end of the spectrum, research infrastructure supports construction, maintenance, and upgrades for telescopes that explore galaxies "far, far away," where distance is measured in millions of light years. While grade school children are using desk top computers and digital hand-held games that have more computing power than mainframe computers of a generation ago, researchers advancing the frontiers of cyberinfrastructure are developing hardware that together with software and communication systems enables petascale computing power. That's one million billion [10^{15}] operations per second – virtually an incomprehensible much less imaginable number if the results weren't there

to be reckoned with. For example, a million billion seconds would work out to be 32 million years.

The significance of the Research Infrastructure goal is easier to grasp if one thinks of these investments as the critical facilities, tools, and resources that breach the boundaries of yesterday's research and educational programs and enable new and more challenging questions to be answered while enriching educational experiences for graduate students and postdoctoral scholars. NSF's Research Infrastructure investments are on the seas with ships carrying equipment and investigators to and from the Antarctic, and under the seas with submarines that explore the seabed. They are on virtually every continent with telescopes, particle detectors, and cyberinfrastructure collaborations. In addition to petascale computing tools, NSF also supports the preparation of searchable digital libraries and enormous databases that offer better teaching aids for K-12 teachers and students, or facilitate storm prediction or atmospheric modeling for the most challenging research questions. Predominantly undergraduate institutions benefit from Research Infrastructure investments in advanced instrumentation and programs that offer targeted research experiences for high school and college students to attract and train American students in STEM disciplines. Research-intensive institutions and special subject centers receive funding from NSF to develop new research tools and to apply unique research capabilities targeted to practical purposes that will benefit the public. NSF's Research Infrastructure portfolio also includes the collection and analysis of data related to STEM for public information and national science policy analysis; NSF's Science and Engineering Indicators 2008, the foremost compendium of quantitative STEM data, is regarded internationally as the gold standard of such reports. The flavor and vast impact of some of these extraordinary "enablers" in each of the programmatic areas is highlighted below. The Committee selected the following highlights as examples of significant achievements in the area of Research Infrastructure.

Major Multi-User Research Facilities

NSF's major multi-user facilities primarily benefit scientific inquiry while providing opportunities for integrating education and research. How safe is a modern-day operating hospital room in a moderate to severe earthquake? An investigator from the University of Nevada-Reno (**Hospital Room Shook Up in First Seismic Experiment of Its Kind**, *Highlight 14938, Awards 0721399 and 0402490*) used the Structural Engineering and Earthquake Simulation Laboratory at the University of Buffalo to explore the impact of shaking on nonstructural elements such as portable equipment, wall-mounted EKGs, ceilings, pipes, and internal walls in a model hospital room. Their findings will help hospitals to anticipate the impact and plan accordingly for the safety of patients and hospital personnel. Researchers at Stanford University (**Holding the San Andreas Fault in our Hands**, *Highlight 14818, Award 0323938*) have been amassing data from samples bored into the San Andreas Fault, the most notorious earthquake zone in the United States. Scientists are using these samples to better understand episodic tremors and slips – the little fault line activities that accumulate strain slowly along the Fault plates. For the West Coast residents who live with the San Andreas Fault as a neighbor, improved understanding of fault behavior is practical research with tremendous potential public

"**When Planets Collide**" sounds like a Star Wars movie plot or a GameBoy title. But this is the report of exciting observations by a team from UCLA and the Spitzer Science Center from NSF's Gemini Observatory, which supports telescopes in Hawaii and Chile for observing from both the Northern and Southern hemispheres (*Highlight 15617, Award 0525280*). Astronomers have found the first clear evidence of planet formation through observation of young stony planets which appear to have formed from a collision around one of the stars in the Pleiades clusters. Northern winter sky watchers recognize the Pleiades as one of the most brilliant star clusters.

Instrumentation

A group of engineers at the National High Magnetic Field Laboratory at Florida State University (**Novel Technique to Study the Structure of Proteins**, *Highlight 16236, Award 0084173)* have developed a novel probe that will permit the use of nuclear magnetic resonance (NMR) for the study of proteins that don't dissolve in water. These new tools are opening up a new frontier in protein structure determination.

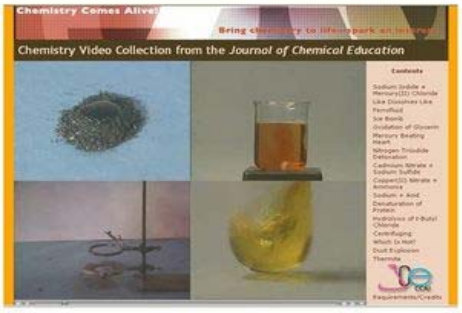
Development of an In-Line Cylinder Bore Inspection System (*Highlight 15077, Award 0723669*) features an In-line Cylinder Bore Inspection System. This Small Business Innovation Research (SBIR) award to Industrial Optical Measurement Systems supported transformative research that replaces inefficient human visual inspection of cylinders of engine blocks with an automated total inspection of cylinder bore surface finish at the speed of a production line. This novel probe pushes automation and efficiency up a notch in the highly competitive automotive market with a potential to stem the market share loss of domestic producers.

In the midst of all this sophistication, there is also room in the NSF portfolio to explore good old-fashioned slime. For many youngsters, a little "play" with worms could be the pathway to a scientific career. The Nebraska State Museum teamed with a local academic lab to lead some middle schoolers for a romp through parasitology (**The Worms Crawl In, The Worms Crawl Out!**, *Highlight 15805, Award 0646356*). What's not to like about cuddly worms, a fair portion of yuck, lots of curiosity, an admirable "ick" factor, worm humor, and learning. This project demonstrates that attracting young people into scientific careers may begin with a real lab experience on a college campus. These students found out the getting a 'hands-on" worm experience was better than just watching "CSI." NSF continues these enriched experiences for potential STEM careers through programs at minority and primarily undergraduate institutions providing sophisticated research instrumentation and summer research participation programs to allow students to preview scientific and technical opportunities.

Cyberinfrastructure

NSF's leadership in high performance computing is generating computing capacities and capabilities that approach petascale ranges. Solving problems at a scale that was unimaginable and beyond our reach just a few years ago is now within reach. NSF's investments help anticipate and resolve the real problems and challenges of petascale computing: storage, manipulation, and mining of massive amounts of data that rely on complex hardware architectures, networking of parallel computing power, and heroic software solutions.

Computer Recognizes Facial Expressions Better Than Humans Can (*Highlight 16396, Awards 0454233 and 0627822*) describes how researchers at the University of Buffalo and University of California, San Diego have developed the Computer Expression Recognition Toolbox that can be used by social scientists, education researchers, cognitive neuroscientists, and vision researchers. A particularly interesting finding from their experiments was that automated classifiers were able to differentiate real pain from fake pain significantly better than inexperienced human subjects. Computers were able to detect driver drowsiness with more than 98% accuracy, perhaps telling us that computers can recognize facial expressions better than humans can. Research in these areas will also provide critical information for computer science and engineering efforts to make computers and robots that interact effectively with humans and understand nonverbal behavior.



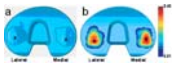
Digital libraries offer delightful educational "shopping trips" for teachers and budding scientists. With **Chemistry Comes Alive**, (*Highlight 14835, Awards 0632303, 0632247 and 0632269*), a collaborative project between the University of Wisconsin and the American Chemical Society, the curious can observe dangerous chemical reactions and learn about demonstrations or experiments that rivet the attention of young students. Dramatic footage and supplemental educational materials make this a wonderfully attractive and easily accessible resource. This project addresses both the Research Infrastructure and Learning goals by providing teachers and students the opportunity to view a diverse array of chemical reactions that demonstrate concepts in chemistry.

Recent advances in computational linguistics enabled by NSF funding have produced the Sanskrit digital library (**International Digital Sanskrit Library Integration**, *Highlight 16177, Awards 0535207 and 0535038*). This resource challenged the most sophisticated computer scientists – because robust techniques involving recognition factors, selection, and mapping rules made this venture a veritable romp in computational linguistics. The digital Sanskrit tool and infrastructure provide an internationally accessible tool that will replace outmoded grammars, reference books, and other printer materials that will facilitate and broaden participation in linguistics research.

NSF's interest in accumulating massive data bases spans disparate fields, from aggregations of huge volumes of astronomical observations to atmospheric histories that promote challenging modeling and simulation research. Climate modeling has direct relevance for global climate change research and policy issues leading to factual, informed decision making. **Creation of a new satellite-based hurricane database** (*Highlight 15823, Award 0614812*) describes the development of the URSAT dataset which contains 170,000 storm-centered satellite observations in over 2,000 storms worldwide. Researchers at the University of Wisconsin and NOAA's

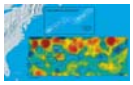
National Climatic Data Center have developed the first global homogeneous record of tropical cyclone intensity estimates from 1978-2006. Hurricanes and tropical storms have a major impact on U.S. and global economy; this database may provide better insight into how increasing temperatures could affect the intensity of hurricanes and cyclones.

Photo Information and Credits



Page A-2 – Comparison of experimental (a) and simulated (b) wear regions for a total knee replacement design after 5 million cycles of walking performed in a knee simulator machine. X's indicate locations of maximum wear. Dotted lines in (a) indicate boundaries of experimental wear regions. Color bar in (b) indicates depth in millimeters of simulated wear regions.
Credit: B.J. Fregly, University of Florida

Page A-3 – Damage from an EF1 tornado. CASA graduate student Patrick Marsh (University of Oklahoma) conducted a damage survey to verify the EF1 tornado identified in CASA data.
Credit: CASA



Page A-3– Data from satellite altimeters (lower inset), which measure sea surface heights, show depressions (blue) and bumps (red) that mark cold- and warm-water eddies in the ocean on June 17, 2005. Researchers tracked the southwestward motion of eddy A4 (light-blue in the upper inset) by ship from June 24 to Sept. 12. They released several drifters and a buoy (colored tracks) to capture the swirling motion of the eddy's currents.
Credit: This figure was drafted by Jim Canavan and provided as a courtesy by Dennis McGillicuddy, WHOI, and the Colorado Center for Astrodynamics Research.

Page A-4 – The retinal prosthesis consists of a camera and transmitter mounted in eyeglasses, an implanted receiver, and a microelectrode array attached to the retina.
Credit: Biomimetic MicroElectronic Systems Engineering Research Center (BMES)

Page A-6 – Astronomers have discovered a solar system analogous to ours containing scaled-down versions of Saturn and Jupiter. The two planets were revealed when the star they orbit crossed in front of a more distant star as seen from Earth. For a two-week period from late March through April 2006, the nearer star magnified the light shining from the farther star. Their finding suggests that our galaxy hosts many star systems like our own.
Credit: Korea Astronomy and Space Science Institute (KASI), Chungbuk National University (CBNU), and Astrophysical Research Center for the Structure and Evolution of the Cosmos (ARCSEC)

Page A-7 – View of the Flight Simulator Environment setup at Tuskegee University
Credit: Tuskegee University

Page A-7 – Two SEEDBEd high school students use micropipettes to move enzyme digested DNA into an electrophoresis gel.
Credit: Cindy Barton, Tulsa Community College

Page A-8– Virtual wolves on the prowl.
Credit: Grant Spickelmier, Minnesota Zoo

Page A-9 – Middle school teachers building models of fullerenes (above) and running an experiment.
Credit: Andrew Greenberg, University of Wisconsin, Madison

Page A-10 – The Emmy-Award winning CYBERCHASE team, featuring Jackie, Inez, Matt, and Digit.
Credit: Sandra Sheppard

Page A-13 – Artist's rendering of what the environment around HD 23514 might look like as two Earth-sized bodies collide.
Credit: Gemini Observatory/Lynette Cook

Page A-13– Student practice combing for ectoparasites.
Credit: Dr. Scott Gardner, University of Nebraska

Page A-14 - Chemistry Comes Alive! website received the 2006 Pirelli *Internet*ional Award "for the effectiveness of this collection of multimedia tools that are designed to enhance chemistry education in schools and universities".
Credit: Journal of Chemical Education Software, a publication of the Division of Chemical Education, Inc. of the American Chemical Society

APPENDIX B: Detailed Results of Stewardship Goal

Area	Performance Milestones and Measures	Results
1. Time-to-Decision	For 70 percent of proposals, 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.	FY 2004 through FY 2008 -- Successful
2. Merit Review	Improve the transparency of our decisions and the quality of the merit review process. • Initiate a mandatory training course for NSF staff on the merit review process. • Continue the efforts begun in FY 2007 to develop metrics to assess the transparency and quality of the merit review process. • Provide a written context statement to the Principal Investigator (PI) whose proposal is awarded or declined that describes the process by which the proposal was reviewed and the context of the decision (such as the number of proposals and awards, information about budget availability, and considerations in portfolio balancing). FY 2008 Target: 95 percent. FY 2008 Result: 95 percent.	FY 2007 & 2008 – Successful A training course is being developed. The Committee of Visitors report template was revised to provide clarity about NSF expectations on the quality and transparency of the merit review process. The target was achieved.
3. Customer Service	Improve customer service to the science, engineering, and education communities. • Improve access to NSF funding data on the NSF website. • Conduct further analysis of selected data related to the working groups on Impact of Proposal Award Management Mechanisms (IPAMM) and Facilitating Transformative and Interdisciplinary Research (FacTIR).	FY 2007 & 2008 - Successful NSF put funding data on Directorate homepages. NSF is analyzing data from a PI survey conducted in 2007 in order to improve ways to process interdisciplinary research proposals.

4. Broadening Participation	Expand efforts to increase participation from underrepresented groups and diverse institutions throughout the United States in all NSF activities and programs.	FY 2007 & 2008 - Successful
	• Update the NSF portfolio of broadening participation programs to facilitate NSF-wide coordination of efforts to more actively engage people, from all types of institutions through the United States, in the science and engineering enterprise.	NSF has updated the portfolio and published it on the NSF website.
	• Initiate the development of capability to support a searchable database of NSF proposal reviewers.	NSF is developing more modern tools and capabilities in order to expand the pool of reviewers.
	• Develop a standard orientation module for NSF panels that includes information on mitigation of implicit bias in the merit review process.	A module was piloted and will be put on the NSF internal website.
	• Initiate the development of program reference codes to track broadening participation investments.	Upon investigation, the use of tracking codes proved to be not viable, and alternative methods are being explored.
5. Management of Large Facilities	Ensure the efficient and effective management of the construction and operation of large facilities.	
	• For all MREFC facilities under construction, keep negative cost and schedule variance to less than 10 percent.	FY 2007 & 2008 -- Not Successful One facility out of five did not meet the schedule variance goal
	• For facilities in the operational phase, keep operating time lost to less than 10 percent for 90 percent of those facilities.	FY 2007 & 2008 – Successful All 19 facilities met the goal
	• Conduct a Business System Review at least once per 5-year award cycle for all institutions hosting NSF-supported large facilities, with a minimum of four planned per year.	FY 2008 – Successful (a new measure in FY 2008)

6. Post-Award Monitoring	Fully implement NSF's program of post-award financial and administrative monitoring, in order to test our risk-based identification model against our mitigation strategy of increasing methods of oversight.	FY 2007 & 2008 - Successful
	• Apply the risk assessment results in order to develop the FY 2008 monitoring plan (on-site visits, desk reviews, and FCTR sampling efforts).	All risk assessment results have been applied.
	• Complete 95 percent of projected FY 2008 on-site monitoring visits by the end of FY 2008.	100 percent of on-site visits has been completed.
	• Complete 95 percent of projected FY 2008 desk reviews by the end of FY 2008.	100 percent of desk reviews has been completed.
	• Complete 95 percent of projected FY 2008 FCTR transaction testing by the end of FY 2008.	100 percent of FCTR transaction testing has been completed.
7. E-Government	Establish an E-Government Implementation Plan.	FY 2007 & 2008 - Successful
	• Achieve 90 percent of major E-Government Plan implementation milestones.	100 percent of implementation milestones have been completed.
	• Post 100 percent of discretionary grants applications on Grants.gov as specified in NSF Ramp-Up Plan.	100 percent of discretionary grants applications have been posted.
	• Deliver initial release of Research.gov to include application status service that improves work processes and technology to support the research grantee community.	The initial release of Research.gov has been completed.
8. IT Security	Conduct a successful FISMA (Federal Information Security Management Act) IT Program Review.	FY 2007 & 2008 - Successful
	• Ensure major applications and general support systems certification and accreditations are current and up to date.	100 percent of major applications and general support systems have been certified and accredited.

	• Ensure that 96 percent or more of IT systems are installed in accordance with security configurations.	100 percent of IT systems have been installed in accordance with security configurations.
	• Ensure that 90 percent or more of applicable systems have Privacy Impact Assessments.	100 percent of applicable systems have Privacy Impact Assessments.

Appendix C: FY 2008 Program Assessment Rating Tool (PART) Performance Measure Results

In FY 2008, 17 of 23 PART targets, or 74 percent, were achieved and are summarized below. Detailed results on each goal follow.

1. Research Grants: Time to Decision	●
2. Education Grants: Time to Decision	●
3. Major Research Instrumentation (MRI) Program: Time to Decision	●
4. Science and Engineering Centers: Time to Decision for Pre-Proposals	■
5. Research Grants: Percentage of Proposals from Outside the Top 100 Institutions	●
6. Education Grants: Percentage of Proposals from Outside the Top 100 Institutions	■
7. Major Research Instrumentation (MRI) Program: Percentage of Proposals from Outside the Top 100 Institutions	●
8. CAREER Program: Number of Applicants from Minority-Serving Institutions	●
9. Graduate Research Fellowship Program: Number of Applicants from Underrepresented Groups	●
10. SBIR/STTR Programs: Percentage of Phase I Awards to New PIs	■
11. Science and Engineering Centers: Percentage of Non-Academic Partner Institutions	■
12. GRF, IGERT, GK-12 Programs: Number of Graduate Students Funded	■
13. MREFC Facilities: Construction Cost and Schedule	■
14. Major Multi-User Research Facilities: Operations	●
15. FFRDC Operational Facilities	●
16. National Optical Astronomy Observatory (NOAO): Observing Time	●
17. National Center for Atmospheric Research (NCAR): Number of Users of Datasets	●
18. TeraGrid Users	●
19. Polar Programs: Support for Research in the Antarctic	●
20. Polar Programs: Construction Cost and Schedule	●
21. K-12 Math & Science Education: Rigorous Examination of Effectiveness of Resources	●
22. K-12 Math & Science Education: Rigorous Evaluation of DRK-12 Development Projects	●
23. K-12 Math & Science Education: Math & Science Partnerships – Adequate Yearly Progress	●

● Goal Achieved
■ Goal Not Achieved

ANNUAL PERFORMANCE GOAL 1:
RESEARCH GRANTS: TIME-TO-DECISION

Goal: For 70 percent of proposals submitted for Research Grants, inform applicants whether their proposals have been recommended for award or declination within six months of deadline, target date, or proposal receipt date, whichever is later, while maintaining a credible and efficient merit review system.

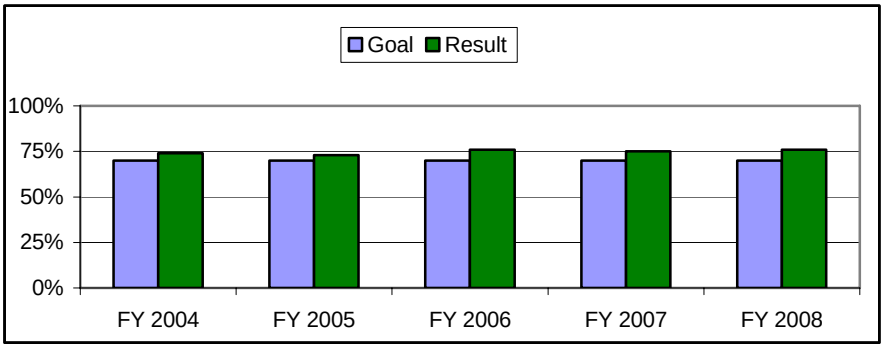
Program Description: NSF's Research Grants program is a set of proposals dealing primarily with "traditional" research projects. Excluded from this category are grants for equipment, education, postdoctoral fellowships, planning and travel grants, and symposia, as well as cooperative agreements for centers and facilities. Also excluded are most of the programs in the Education and Human Resources (EHR) Directorate and the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs.

Intent of the Goal: This goal is intended to ensure that proposal decisions will be made available in a timely manner and conveyed to investigators in order that they may plan activities more effectively. Given the increasing complexity and growing numbers of proposals being submitted to NSF each year, and the increased attention throughout the Foundation to improving the quality and transparency of the merit review process, this is an ambitious goal for all program officers as they manage their proposal workloads and overall portfolios of awards.

FY 2008 Result: NSF achieved this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	70%	74%
FY 2005	70%	73%
FY 2006	70%	76%
FY 2007	70%	75%
FY 2008	70%	76%



Agency Efforts to Improve Performance and Efficiency: The time-to-decision goal was achieved Foundation-wide (under the Stewardship goal) and in three program portfolios: Research Grants, Education Grants, and the Major Research Instrumentation (MRI) Program. NSF program officers are held accountable for making recommendations on funding of proposals in a timely manner (within six months from proposal receipt), and in notifying investigators about these recommendations, while maintaining a credible and efficient merit review system. The time-to-decision goal has been achieved despite the increasing numbers and complexity of proposals submitted to NSF.

PART Evaluation: This goal was established in the Fundamental Science and Engineering (FSE) PART (PART ID: 10004400) conducted in FY 2005.

ANNUAL PERFORMANCE GOAL 2:
EDUCATION GRANTS: TIME-TO-DECISION

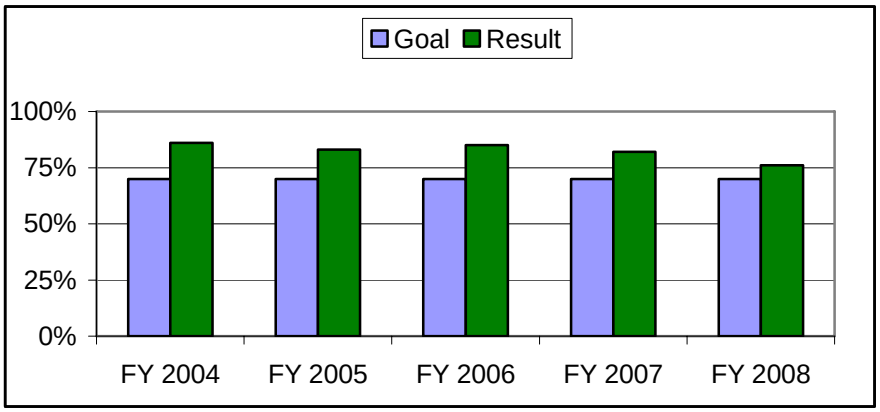
Goal: For 70 percent of proposals submitted to the Directorate for Education and Human Resources (EHR), be able to inform applicants about funding decisions within six months of proposal receipt or deadline, or target date, whichever is later, while maintaining a credible and efficient merit review system.

Program Description: The mission of the Education and Human Resources (EHR) Directorate is to achieve excellence in U.S. science, technology, engineering, and mathematics (STEM) at all levels and in all settings (both formal and informal) in order to support the development of a diverse and well-prepared workforce. EHR Programs include opportunities for K-12 science and math education, undergraduate and graduate education, postdoctoral fellowships, and programs aimed at human resource development and at research on learning in formal and informal settings. A Directorate priority is to ensure that the STEM community is broadly representative of the nation's individuals, types of institutions, geographic regions, and STEM disciplines. Given the increasing complexity and growing numbers of proposals being submitted to NSF each year, and the increased attention throughout the Foundation to improving the quality and transparency of the merit review process, this is an ambitious goal for all program officers as they manage their proposal workload and overall portfolio of awards.

FY 2008 Result: NSF achieved this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	70%	86%
FY 2005	70%	83%
FY 2006	70%	85%
FY 2007	70%	82%
FY 2008	70%	76%



Agency Efforts to Improve Performance and Efficiency: The time-to-decision goal was achieved Foundation-wide (see Stewardship) and in three program portfolios: Research Grants, Education Grants, and the Major Research Instrumentation (MRI) Program. NSF program officers are held accountable for making recommendations on funding of proposals in a timely manner (within six months from proposal receipt), and in notifying investigators about these recommendations, while maintaining a credible and efficient merit review system. The time-to-decision goal has been achieved despite the increasing numbers and complexity of proposals submitted to NSF.

PART Evaluation: This goal was established during two PART evaluations conducted in FY 2004: Support for Small Research Collaborations (PART ID: 10002322), and Support for Research Institutions (PART ID: 10002324).

ANNUAL PERFORMANCE GOAL 3:
MRI PROGRAM: TIME-TO-DECISION

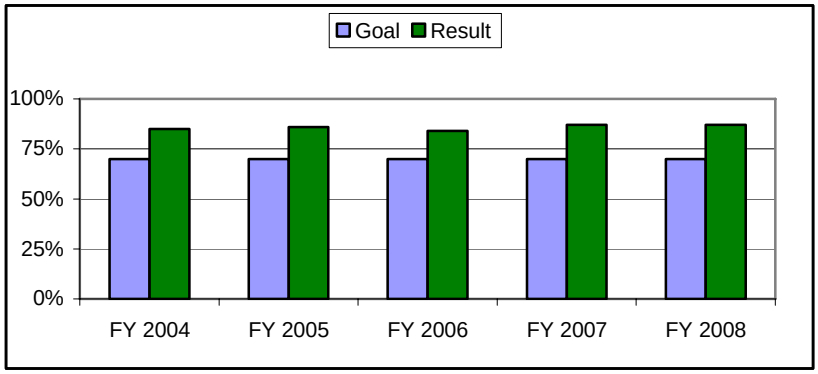
Goal: For 70 percent of the proposals submitted to the Major Research Instrumentation (MRI) Program, be able to inform applicants about funding decisions within six months of proposal receipt or deadline, or target date, whichever is later, while maintaining a credible and efficient merit review system.

Program Description: The Major Research Instrumentation Program is a Foundation-wide, cross-cutting initiative that supports the acquisition and development of instrumentation in fields such as nanotechnology, computing, physical sciences, and materials sciences and engineering. The portfolio reflects state-of-the-art instrumentation, access and training to support modern research approaches, integration of research and education, public/private partnerships, and assistance to minority-serving institutions. Timely availability of proposal decisions enables the investigators to more effectively plan activities. Given the increasing complexity and growing numbers of proposals being submitted to NSF each year, and the increased attention throughout the Foundation to improving the quality and transparency of the merit review process, this is an ambitious goal for all program officers as they manage their proposal workload and overall portfolio of awards.

FY 2008 Result: NSF achieved this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	70%	85%
FY 2005	70%	86%
FY 2006	70%	84%
FY 2007	70%	87%
FY 2008	70%	87%



Agency Efforts to Improve Performance and Efficiency: The time-to-decision goal was achieved Foundation-wide (see Stewardship) and in three program portfolios: Research Grants, Education Grants, and the Major Research Instrumentation (MRI) Program. NSF program officers are held accountable for making recommendations on funding of proposals in a timely manner (within six months from proposal receipt), and in notifying investigators about these recommendations, while maintaining a credible and efficient merit review system. The time-to-decision goal has achieved despite the increasing numbers and complexity of proposals submitted to NSF.

PART Evaluation: A time to decision goal was established in the Investment in Research Infrastructure and Instrumentation PART conducted in FY 2006 (PART ID: 10004405).

ANNUAL PERFORMANCE GOAL 4:
NSF SCIENCE AND ENGINEERING CENTERS: TIME TO DECISION FOR PRE-PREPOSALS

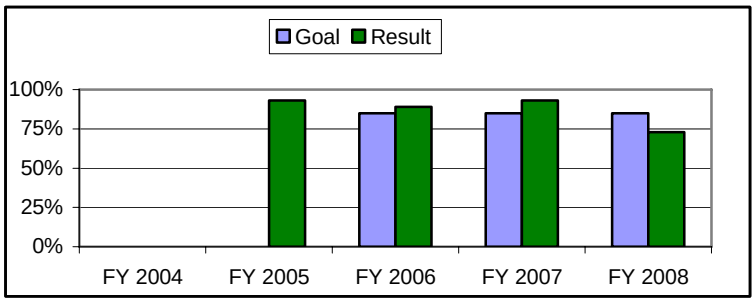
Goal: For 85 percent of pre-proposals submitted to NSF Science and Engineering centers, be able to inform applicants within five months whether they will be invited to submit full proposals.

Program Description: NSF centers enable academic institutions, along with their non-academic partner institutions to integrate NSF's strategic goals of *Discovery*, *Learning*, and *Research Infrastructure* on scales that will significantly impact important science and engineering fields and cross-disciplinary areas through large-scale organized efforts. NSF centers 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. Included in this category are seven Centers programs: Centers for Analysis and Synthesis, Centers for Chemical Innovation, Engineering Research Centers, Materials Research Science and Engineering Centers, Nanoscale Science and Engineering Centers, Science and Technology Centers, and Science of Learning Centers. This goal is intended to ensure that decisions on pre-proposals will be made available and conveyed to investigators so that that they may have enough time to prepare full proposals if invited to do so.

FY 2008 Result: NSF did not achieve this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	N/A	N/A
FY 2005	N/A	93%
FY 2006	85%	89%
FY 2007	85%	93%
FY 2008	85%	73%



Agency Efforts to Improve Performance and Efficiency: Because not all of NSF's Centers hold competitions each year, the period of performance for this goal is two years, FY 2007-2008. During that period, four Centers competitions were held: the Centers for Analysis and Synthesis, the Centers for Chemical Innovation, the Engineering Research Centers (ERCs), and the Materials Research Science and Engineering Centers. In the four competitions, only one program, the ERCs, did not meet the goal of five months from the date of submission of a pre-proposal to notification of the PI on whether to submit a full proposal. The ERC Program's result was six months, which is the same as the Foundation-wide time to decision efficiency goal.

PART Evaluation: This goal was established in the Science and Engineering Centers PART Program conducted in FY 2006 (PART ID: 10004404).

ANNUAL PERFORMANCE GOAL 5:
RESEARCH GRANTS: PERCENTAGE OF PROPOSALS FROM OUTSIDE THE TOP 100 INSTITUTIONS

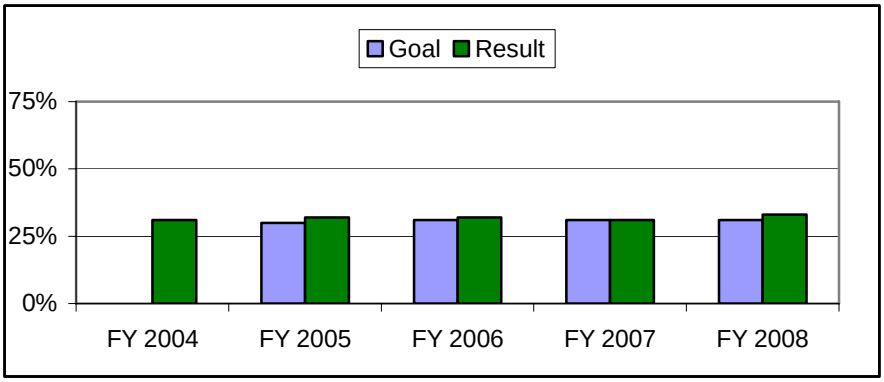
Goal: Increase the percentage of proposals for research grants from academic institutions not in the top 100 of NSF funding recipients.

Program Description: NSF's Research Grants program is a set of proposals dealing primarily with "traditional" research projects. Excluded from this category are grants for equipment, education, postdoctoral fellowships, planning and travel grants, and symposia, as well as cooperative agreements for centers and facilities. Also excluded are most of the programs in the Education and Human Resources (EHR) Directorate and the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. This goal is intended to expand NSF's efforts to increase participation from underrepresented groups and diverse institutions throughout the United States in all NSF activities and programs.

FY 2008 Result: NSF achieved this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	N/A	31%
FY 2005	30%	32%
FY 2006	31%	32%
FY 2007	31%	31%
FY 2008	31%	33%



Agency Efforts to Improve Performance and Efficiency: NSF continues to broaden participation through outreach to the institutions that are not in the top 100 of funding institutions. Examples of such activities are "NSF Days," organized by the Office of Legislative and Public Affairs; regional grants workshops organized by the Office of Budget, Finance and Award Administration; and presentations on program opportunities by NSF staff at professional meetings throughout the country. NSF has established a Framework for Action on Broadening Participation, available on NSF's website. http://www.nsf.gov/od/broadeningparticipation/bp.jsp

PART Evaluation: This goal was established in the Fundamental Science and Engineering (FSE) PART conducted in FY 2005 (PART ID: 10004400).

ANNUAL PERFORMANCE GOAL 6:
EDUCATION GRANTS: PERCENTAGE OF PROPOSALS FROM OUTSIDE THE TOP 100 INSTITUTIONS

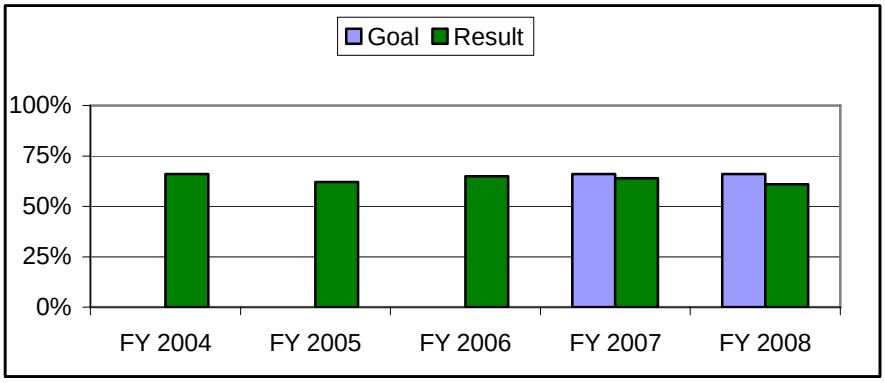
Goal: Increase the percentage of proposals submitted to the Directorate for Education and Human Resources (EHR) programs from academic institutions not in the top 100 of NSF funding recipients.

Program Description: The mission of the Education and Human Resources (EHR) Directorate is to achieve excellence in U.S. science, technology, engineering, and mathematics (STEM) at all levels and in all settings (both formal and informal) in order to support the development of a diverse and well-prepared workforce. EHR Programs include opportunities for K-12 science and math education, undergraduate and graduate education, postdoctoral fellowships, and programs aimed at human resource development and at research on learning in formal and informal settings. One of the Directorate's priorities is to ensure that the STEM community is broadly representative of the nation's individuals, types of institutions, geographic regions, and STEM disciplines. This goal is intended to expand NSF's efforts to increase participation from underrepresented groups and diverse institutions throughout the United States in all NSF activities and programs.

FY 2008 Result: NSF did not achieve this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	N/A	66%
FY 2005	N/A	62%
FY 2006	N/A	65%
FY 2007	66%	64%
FY 2008	66%	61%



Agency Efforts to Improve Performance and Efficiency: NSF continues its efforts to broaden participation through outreach to the institutions that are not in the top 100 of funding institutions. Examples of such activities are "NSF Days," organized by the Office of Legislative and Public Affairs; regional grants workshops organized by the Office of Budget, Finance and Award Administration; and presentations on program opportunities by NSF staff at professional meetings throughout the country. Such outreach activities are based on funds available for staff travel. It is important to note that NSF has established a Framework for Action on Broadening Participation, available on NSF's website. http://www.nsf.gov/od/broadeningparticipation/bp.jsp

PART Evaluation: This goal was established during two PART evaluations conducted in FY 2004: Support for Small Research Collaborations (PART ID: 10002322), and Support for Research Institutions (PART ID: 10002324).

ANNUAL PERFORMANCE GOAL 7:
MRI PROGRAM: PERCENTAGE OF PROPOSALS FROM OUTSIDE THE TOP 100 INSTITUTIONS

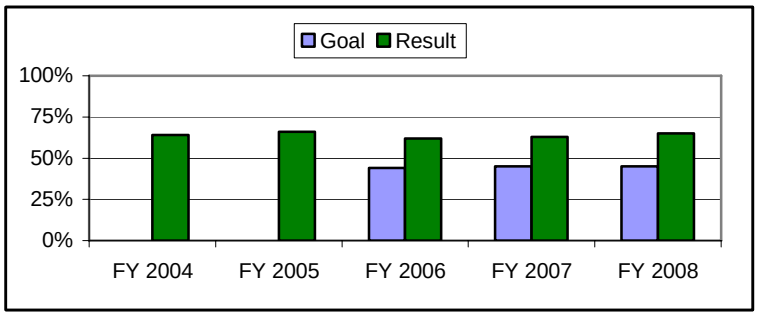
Goal: Maintain a high percentage of proposals submitted to the Major Research Instrumentation (MRI) Program from academic institutions not in the top 100 of NSF funding recipients.

Program Description: The Major Research Instrumentation Program is a Foundation-wide, cross-cutting initiative that supports the acquisition and development of instrumentation in fields such as nanotechnology, computing, physical sciences, and materials sciences and engineering. The portfolio of MRI awards reflects state-of-the-art instrumentation, access and training to support modern research approaches, integration of research and education, and public/private partnerships. To broaden participation from underrepresented groups and diverse institutions throughout the United States, the MRI Program provides extensive support to teaching-intensive and minority serving institutions, including Historically Black Colleges and Universities, Tribal Colleges, and community colleges, with a focus on research training.

FY 2008 Result: NSF achieved this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	N/A	64%
FY 2005	N/A	66%
FY 2006	44%	62%
FY 2007	45%	63%
FY 2008	45%	65%



NOTE: The goals for FY 2006-2009 shown in the charts above were established in FY 2006 during the PART evaluation on NSF's Research Infrastructure and Instrumentation (I&I) Program, which had several disparate program components (Digital Library, Science Resources Statistics, Shared Cyberinfrastructure Tools, and the Major Research Instrumentation Program). However, under the new Strategic Plan, which covers FY 2006 -2011, the I&I Program category does not exist. Therefore, NSF is reporting results only for the MRI Program component (see PART Evaluation, below).

Agency Efforts to Improve Performance and Efficiency: NSF continues to broaden participation through outreach to the institutions that are not in the top 100 of funding institutions. Examples of such activities are "NSF Days," organized by the Office of Legislative and Public Affairs; regional grants workshops organized by the Office of Budget, Finance and Award Administration; and presentations on program opportunities by NSF staff at professional meetings throughout the country. NSF has established a Framework for Action on Broadening Participation, available on NSF's website. http://www.nsf.gov/od/broadeningparticipation/bp.jsp

PART Evaluation: This goal was established in the Investment in Research Infrastructure and Instrumentation PART conducted in FY 2006 (PART ID: 10004405). Because the Research Infrastructure and Instrumentation program category no longer exists under NSF's new Strategic Plan, the Foundation established a related performance measure for one of its major components, the MRI Program.

ANNUAL PERFORMANCE GOAL 8:
CAREER PROGRAM: NUMBER OF APPLICANTS FROM MINORITY-SERVING INSTITUTIONS

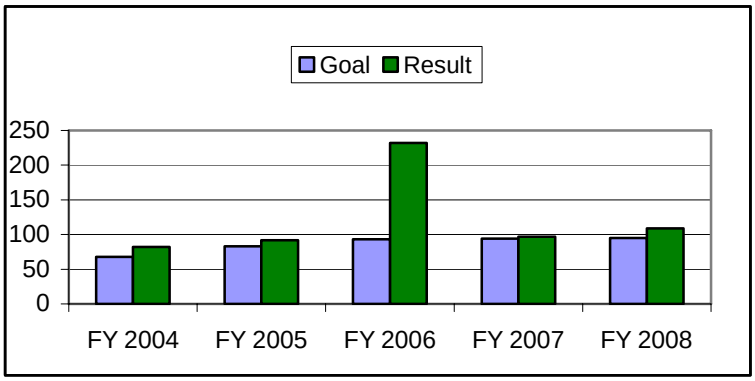
Goal: Increase the number of applicants for Faculty Early Career Development (CAREER) awards from investigators at Minority-Serving Institutions.

Program Description: The Faculty Early Career Development (CAREER) Program is a Foundation-wide activity that offers the National Science Foundation's most prestigious awards in support of the early career-development activities of those teacher-scholars who most effectively integrate research and education within the context of the mission of their organization. NSF encourages submission of CAREER proposals from junior faculty at all eligible organizations and especially encourages women, members of underrepresented minority groups, and persons with disabilities to apply. This goal is intended to expand NSF's efforts to increase participation from underrepresented groups and diverse institutions throughout the United States in all NSF activities and programs.

FY 2008 Result: NSF achieved this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	68	82
FY 2005	83	92
FY 2006	93	232
FY 2007	94	97
FY 2008	95	109



Agency Efforts to Improve Performance and Efficiency: The Foundation continues its efforts to broaden participation in all activities and programs from groups that are underrepresented in science and engineering. NSF has established a Framework for Action on Broadening Participation, available on NSF's website. http://www.nsf.gov/od/broadeningparticipation/bp.jsp

PART Evaluation: This goal was established in the Support for Individual Researchers PART Program conducted in FY 2003 (PART ID: 10001148).

ANNUAL PERFORMANCE GOAL 9:
GRADUATE RESEARCH FELLOWSHIP PROGRAM:
NUMBER OF APPLICANTS FROM UNDERREPRESENTED GROUPS

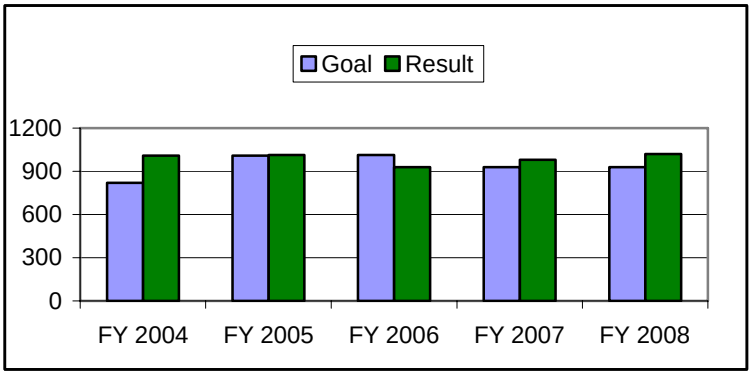
Goal: Increase the number of applicants to the Graduate Research Fellowship Program (GRFP) from groups that are underrepresented in the science and engineering workforce.

Program Description: The National Science Foundation aims to ensure the vitality of the human resource base of science, technology, engineering, and mathematics in the United States and to reinforce its diversity by offering approximately 1,000 graduate fellowships per year in this competition. The Graduate Research Fellowship provides three years of support for graduate study leading to research-based master's or doctoral degrees and is intended for students who are at the early stages of their graduate study. The Graduate Research Fellowship Program (GRFP) invests in graduate education for a cadre of diverse individuals who demonstrate their potential to successfully complete graduate degree programs in disciplines relevant to the mission of the National Science Foundation. This goal is intended to expand NSF's efforts to increase participation from underrepresented groups and diverse institutions throughout the United States in all NSF activities and programs.

FY 2008 Result: NSF achieved this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	821	1009
FY 2005	1010	1013
FY 2006	1014	929
FY 2007	930	980
FY 2008	930	1021



Agency Efforts to Improve Performance and Efficiency: NSF has begun a more aggressive outreach effort that includes holding workshops and webinars for undergraduate students at Minority Serving Institutions on how to prepare competitive fellowship applications, working with local and state organizations to reach out to middle and high school students to generate interest in science and engineering, and preparing students in the Louis Stokes Alliances for Minority Participation (LSAMP) Bridge to the Doctorate Program to apply to the GRFP. NSF has established a Framework for Action on Broadening Participation, available on NSF's website. http://www.nsf.gov/od/broadeningparticipation/bp.jsp

PART Evaluation: The goal was established in the Support for Individual Researchers PART Program conducted in FY 2003 (PART ID: 10001148).

ANNUAL PERFORMANCE GOAL 10:
SBIR/STTR PROGRAMS: PERCENTAGE OF PHASE I AWARDS TO NEW PIs

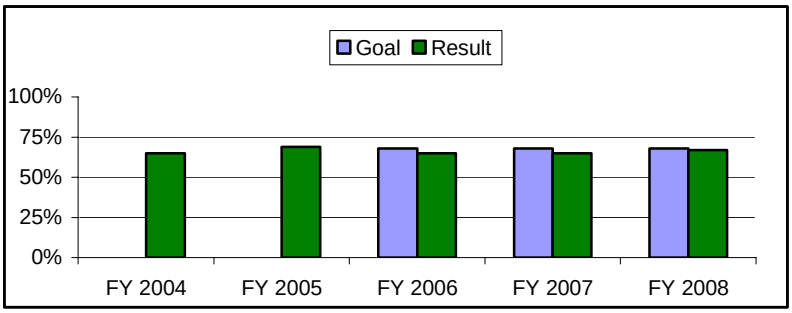
Goal: Maintain a high percentage of awards to new principal investigators (new companies**)** in Phase I of the Small Business Innovation Research (SBIR) and the Small Business Technology Transfer (STTR) Programs.

Program Description: The SBIR/STTR Programs stimulate technological innovation in the private sector by strengthening the role of small business concerns in meeting Federal research and development needs, increasing the commercial application of federally supported research results, and fostering and encouraging participation by socially and economically disadvantaged and women-owned small businesses. The significant difference between the SBIR and STTR programs is that STTR requires researchers at universities and other research institutions to play a significant intellectual role in the conduct of each STTR project. These university-based researchers, by joining forces with a small company, can spin off their commercially promising ideas while they remain primarily employed at the research institution. The SBIR/STTR Program is renewing efforts to attract and fund quality proposals from new principal investigators (new companies) through such means as co-funding with the EPSCoR Program; outreach at national, regional, state, and local small business events; supplementing NSF programs such as Research Experiences for Undergraduates (REU) and Research Experiences for Teachers (RET); and encouraging more participation from women and underrepresented groups.

FY 2008 Result: NSF did not achieve this goal. The results are lower than the target, but improved over the prior year's performance. The performance goal was set at an approximate target level, and the deviation from that level is slight (one percent). There was no effect on overall program performance.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	N/A	65%
FY 2005	N/A	69%
FY 2006	68%	65%
FY 2007	68%	65%
FY 2008	68%	67%



Agency Efforts to Improve Performance and Efficiency: NSF staff are exploring ways to increase the number of proposals from women and underrepresented minorities to the SBIR and STTR programs. For more information, see: http://www.nsf.gov/eng/iip/sbir/diversity/index.jsp. NSF is inviting supplemental proposals from SBIR/STTR Phase II grantees who have successfully taken an SBIR/STTR project through Phase I, Phase II/IIB to the market. The grantees will serve as mentors to other small businesses that have never submitted a proposal to NSF, including those from underrepresented groups within their communities. The supplements are intended to broaden participation and to increase the diversity of small businesses within the NSF SBIR/STTR program. For more information see the program: Dear Colleague Letter: DCL.

PART Evaluation: This goal was established in the Capability Enhancement of Researchers, Institutions, and Small Businesses PART Program conducted in FY 2006 (PART ID: 10004405).

ANNUAL PERFORMANCE GOAL 11:
NSF SCIENCE AND ENGINEERING CENTERS:
PERCENTAGE OF NON-ACADEMIC PARTNER INSTITUTIONS

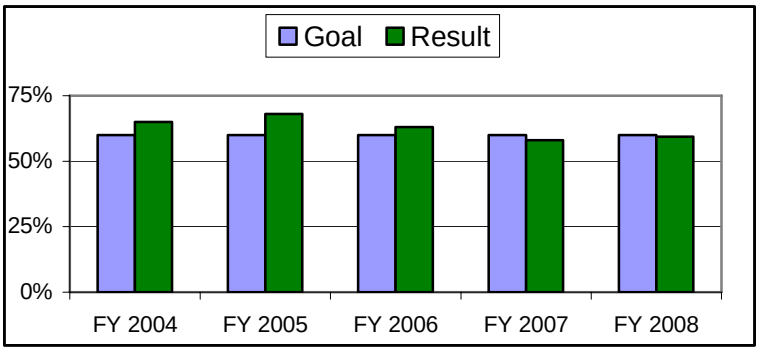
Goal: For all NSF centers, maintain a high percentage of partner institutions that are non-academic institutions (includes industry, state, local, and other Federal agencies).

Program Description: NSF centers program enable academic institutions, along with their non-academic partner institutions to integrate NSF's strategic goals of Discovery, *Learning,* and *Research Infrastructure* on scales that will significantly impact important science and engineering fields and cross-disciplinary areas through large-scale organized efforts. NSF centers 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. Included in this category are seven Centers programs: Centers for Analysis and Synthesis, Centers for Chemical Innovation, Engineering Research Centers, Materials Research Science and Engineering Centers, Nanoscale Science and Engineering Centers, Science and Technology Centers, and Science of Learning Centers. This goal is intended to contribute to NSF's efforts to broaden participation in its programs by encouraging linkages with non-academic partners throughout the United States, such as national laboratories, research museums, private sector research laboratories, state and local government laboratories, and international collaborations.

FY 2008 Result: NSF did not achieve this goal. The results are lower than the target, but improved over the prior year's performance. The performance goal was set at an approximate target level, and the deviation from that level is slight. There was no effect on overall program performance.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	60%	65%
FY 2005	60%	68%
FY 2006	60%	63%
FY 2007	60%	58%
FY 2008	60%	59%



Agency Efforts to Improve Performance and Efficiency: Four of the seven Centers programs surpassed the target of 60%: Centers for Analysis & Synthesis (84%), Nanoscale Science & Engineering Centers (65%), Science and Technology Centers (79%), and Science of Learning Centers (65%). The remaining three Centers programs did not meet the target: Centers for Chemical Innovation (37%), Engineering Research Centers (51%), and Materials Research Science and Engineering Centers (50%). Renewed efforts are being made to increase the participation of non-academic institutions through outreach to the science and engineering community and international partnerships.

PART Evaluation: This goal was established in the Science and Engineering Centers PART Program conducted in FY 2006 (PART ID: 10004404).

ANNUAL PERFORMANCE GOAL 12:
GRF, IGERT, GK-12 PROGRAMS: NUMBER OF GRADUATE STUDENTS FUNDED

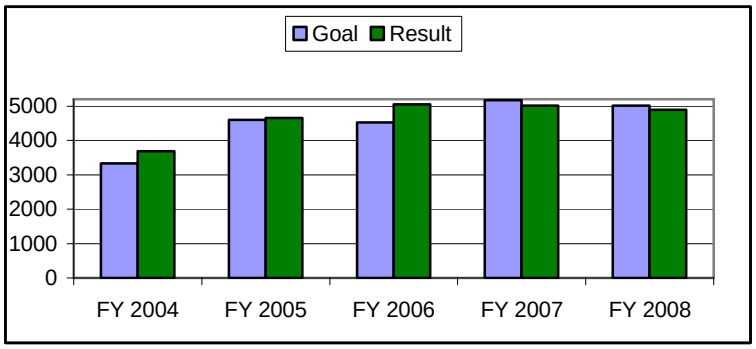
Goal: Increase the number of graduate students funded through fellowships or traineeships in the Graduate Research Fellowship Program (GRFP), the Integrative Graduate Education and Research Traineeships (IGERT) Program, and the Graduate Teaching Fellows in K-12 Education (GK-12) Program.

Program Descriptions: The **Graduate Research Fellowship Program (GRFP)** provides three years of support for graduate study leading to research-based master's or doctoral degrees and is intended for students at the early stages of their graduate study. The **Integrative Graduate Education and Research Traineeship (IGERT) program** aims to educate U.S. Ph.D. scientists and engineers who will pursue careers in research and education, with the interdisciplinary backgrounds, deep knowledge in chosen disciplines, and technical, professional, and personal skills to become, in their own careers, leaders and creative agents for change. The **Graduate Teaching Fellows in K-12 Education (GK-12) program** provides funding to graduate students in science, technology, engineering, and mathematics (STEM) disciplines to acquire additional skills to prepare them for professional and scientific careers in the 21st century.

FY 2008 Result: NSF did not achieve this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	3329	3681
FY 2005	4600	4648
FY 2006	4525	5049
FY 2007	5175	5010
FY 2008	5011	4891



Agency Efforts to Improve Performance and Efficiency: This goal covers three programs that support graduate students. The IGERT program exceeded its FY 2007 result, supporting 48 more students. In the GRFP, the result reported is only a snapshot of the fellows on tenure on 9/30/08. Some fellows completed their programs early, and some new fellows had not yet started their tenure. The same holds true for the GK-12 Program, where old awards are spending down and new awardees have not yet achieved a full cohort of fellows. NSF proposes to increase the number of graduate students supported in the GRFP by 22 percent in its FY 2009 Budget Request.

PART Evaluation: This goal was established in the Support for Individual Researchers PART Program conducted in FY 2003 (PART ID: 10001148).

ANNUAL PERFORMANCE GOAL 13:
MREFC FACILITIES: CONSTRUCTION COST AND SCHEDULE

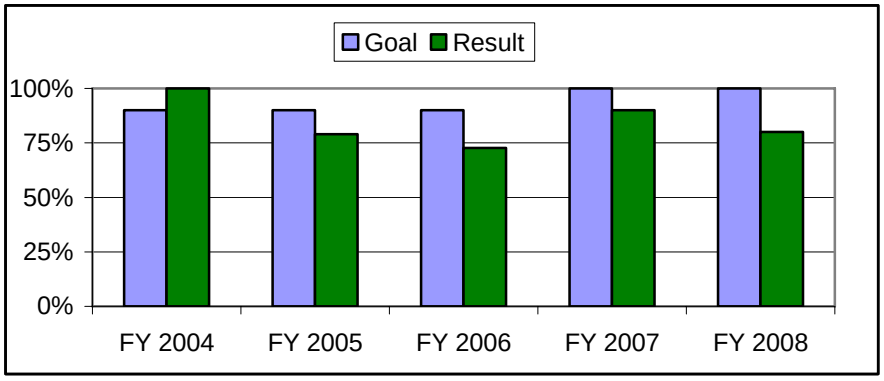
Goal: For all facilities in the Major Research Equipment and Facilities Construction (MREFC) account, keep negative cost and schedule variances to less than ten percent.

Program Description: In FY 2008, cost and schedule variances were tracked for five major facilities under construction: the Atacama Large Millimeter Array (ALMA), EarthScope, the IceCube Neutrino Observatory, the Scientific Ocean Drilling Vessel (SODV), and the South Pole Station Modernization (SPSM) project. Earned Value Management (EVM), a widely accepted project management tool for measuring progress, is used for this goal.

FY 2008 Result: NSF did not achieve this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance :

	Goal	Result
FY 2004	90%	100%
FY 2005	90%	79%
FY 2006	90%	73%
FY 2007	100%	90%
FY 2008	100%	80%



Agency Efforts to Improve Performance and Efficiency: Only one out of the five MREFC projects, the Scientific Ocean Drilling Vessel (SODV), did not achieve the schedule variance goal. The SODV activity is paced by shipyard work to refit and upgrade the vessel. Progress by the shipyard has been slower than expected. To improve performance, a risk management plan is in place, and highest level risks are reviewed continuously by the SODV Conversion Management Team and regularly by the SODV Independent Oversight Committee.

PART Evaluation: This goal was established in the Construction and Operations of Research Facilities PART Program (PART ID: 10001145), conducted in FY 2003. Through FY 2006, the goal applied to as many as 11 construction projects, and the target was set at 90 percent to stay within 10 percent of the approved project plan. In FY 2007, the goal was revised to apply to only the five projects named above, and the target was set at 100 percent.

ANNUAL PERFORMANCE GOAL 14:
MAJOR MULTI-USER RESEARCH FACILITIES: OPERATIONS

Goal: For 90 percent of NSF facilities in the operational phase, keep operating time lost due to unscheduled downtime to less than ten percent.

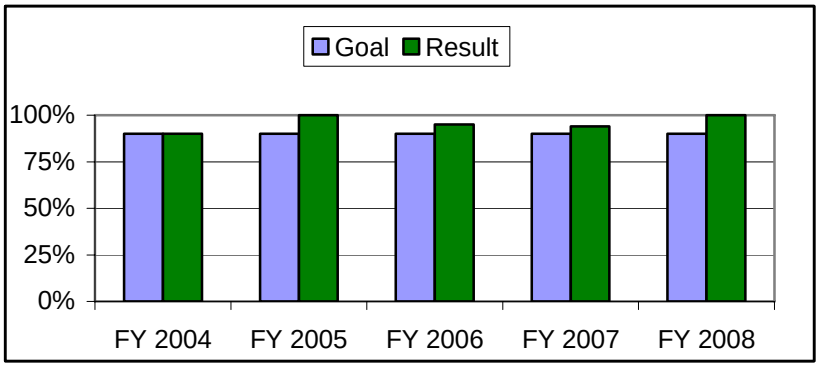
Program Description: NSF investments provide state-of-the-art tools for research and education, such as multi-user research facilities, distributed instrumentation networks and arrays, accelerators, telescopes, research vessels, aircraft, and earthquake simulators. In addition, investments in internet-based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

This goal applies to 19 operational facilities: Academic Research Fleet, A Toroidal Large Angle Spectrometer (ATLAS), Compact Muon Solenoid (CMS), Cornell Electron Storage Ring (CESR), Gemini Observatory, IceCube, Incorporated Research Institutions for Seismology (IRIS), Laser Interferometer Gravitational Wave Observatory (LIGO), National High Magnetic Field Laboratory (NHMFL), National Nanofabrication Infrastructure Network (NNIN), National Superconducting Cyclotron Laboratory (NSC), Network for Earthquake Engineering Simulation (NEES), National Astronomy and Ionosphere Center (NAIC), National Center for Atmospheric Research (NCAR)-Earth Observing Laboratory, National Center for Atmospheric Research (NCAR)-Scientific Computing Division, National Solar Observatory (NSO), National Optical Astronomy Observatory (NOAO), National Radio Astronomy Observatory (NOAO), and U.S. Antarctic Program-Operations.

FY 2008 Result: NSF achieved this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	90%	90%
FY 2005	90%	100%
FY 2006	90%	95%
FY 2007	90%	94%
FY 2008	90%	100%



Agency Efforts to Improve Performance and Efficiency: To provide the flexibility necessary for NSF to report realistic goals for operational large facilities, the level of success is maintained at 90% of those facilities. Beginning in FY 2005, the threshold for reporting was raised to $8M per year, to provide consistent definitions of "large facilities."

PART Evaluation: This goal was established in the Construction and Operations of Research Facilities PART Program conducted in FY 2003 (PART ID: 10001145).

ANNUAL PERFORMANCE GOAL 15:
FFRDC OPERATIONAL FACILITIES

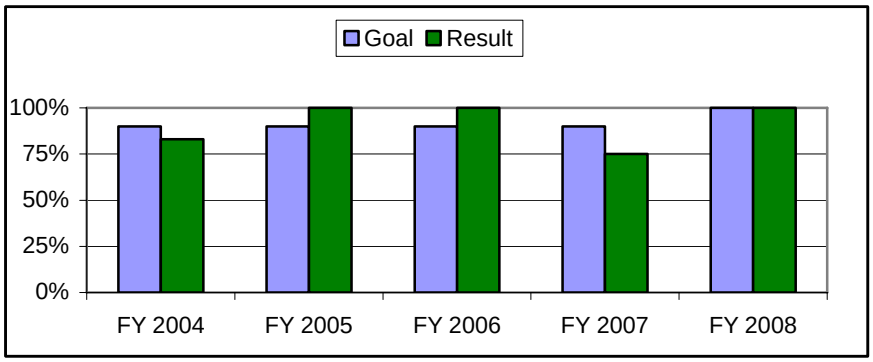
Goal: For 90 percent of NSF's Federally Funded Research and Development Centers (FFRDCs), keep operating time lost to less than ten percent.

Program Description: This goal applies to four facilities: the National Astronomy and Ionosphere Center (NAIC), National Center for Atmospheric Research (NCAR), National Optical Astronomy Observatory (NOAO), and National Radio Astronomy Observatory (NRAO).

FY 2008 Result: NSF achieved this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	90%	83%
FY 2005	90%	100%
FY 2006	90%	100%
FY 2007	90%	75%
FY 2008	100%	100%



Agency Efforts to Improve Performance and Efficiency: All four FFRDCs achieved this goal.

PART Evaluation: This goal was established in the Federally Funded Research and Development Centers PART conducted in FY 2005 (PART ID: 10004401).

ANNUAL PERFORMANCE GOAL 16:
NOAO OBSERVING TIME

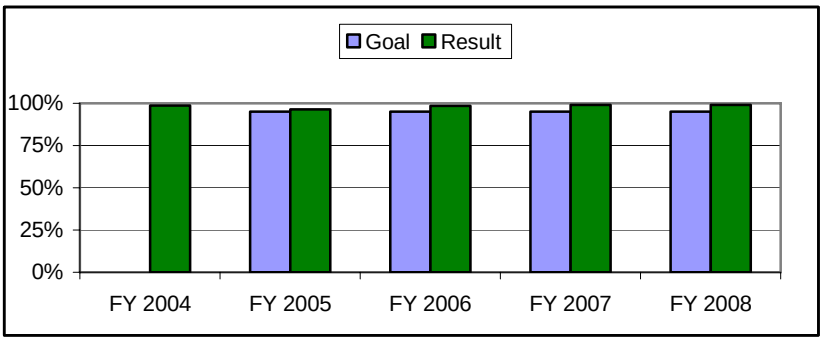
Goal: Award at least 95 percent of the operating time at the National Optical Astronomy Observatory (NOAO) through the NOAO allocation committee.

Program Description: The National Optical Astronomy Observatory supports research in ground-based, nighttime, optical, and infrared astronomy. NOAO is also the gateway for the U.S. astronomical community to the International Gemini Observatory. The percent of operating time awarded through NSF's competitive merit review system does not include engineering time, telescope time committed under international agreements, or fixed-term observing time awarded by limited competitive review through divestment of older telescopes or as a result of partnership with universities or consortia for technology development. The remaining five percent is time that the NOAO Director may award to worthy proposals, targets of opportunity, or NOAO staff after evaluation by the telescope allocation committee.

FY 2008 Result: NSF achieved this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	baseline	98.6%
FY 2005	95%	96.4%
FY 2006	95%	98.5%
FY 2007	95%	99%
FY 2008	95%	99%



Agency Efforts to Improve Performance and Efficiency: The Foundation's merit review criteria of intellectual merit and broader impacts are applied rigorously in all programs.

PART Evaluation: This goal was established in the Federally Funded Research and Development Centers (FFRDC) PART conducted in FY 2005 (PART ID: 10004401).

ANNUAL PERFORMANCE GOAL 17:
NCAR: NUMBER OF USERS OF DATASETS

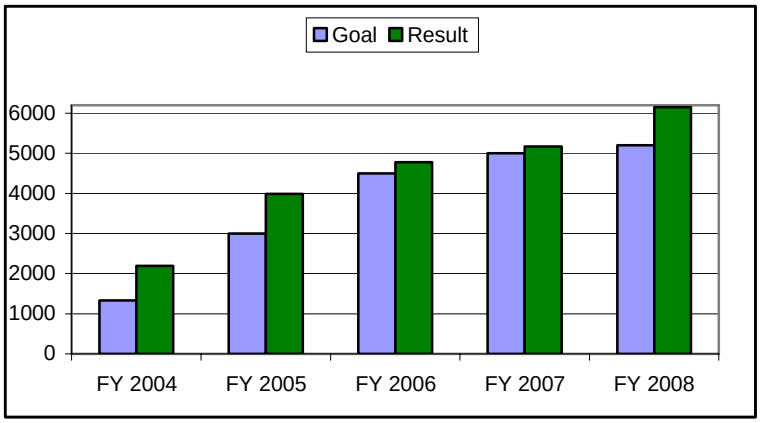
Goal: Increase the number of unique users of datasets at the National Center for Atmospheric Research (NCAR).

Program Description: The National Center for Atmospheric Research serves a broad research community in the atmospheric, environmental, and geosciences. NCAR facilities provide world-class supercomputing services for the development, validation, and execution of large computational models. NCAR is responsible for the curation, archiving, and manipulation of large datasets. This goal tracks the number of users of those datasets who have unique access addresses.

FY 2008 Result: NSF achieved this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	1332	2191
FY 2005	3000	3990
FY 2006	4500	4779
FY 2007	5000	5168
FY 2008	5200	6155



Agency Efforts to Improve Performance and Efficiency: NCAR supports a broad range of science and education programs as well as facilities that serve the atmospheric community, specifically supercomputing and observing facilities. Further details on NCAR activities are available in NCAR's annual reports, available at www.nar.ucar.edu.

PART Evaluation: This goal was established in the Federally Funded Research and Development Centers PART conducted in FY 2005 (PART ID: 10004401).

ANNUAL PERFORMANCE GOAL 18:
TERAGRID USERS

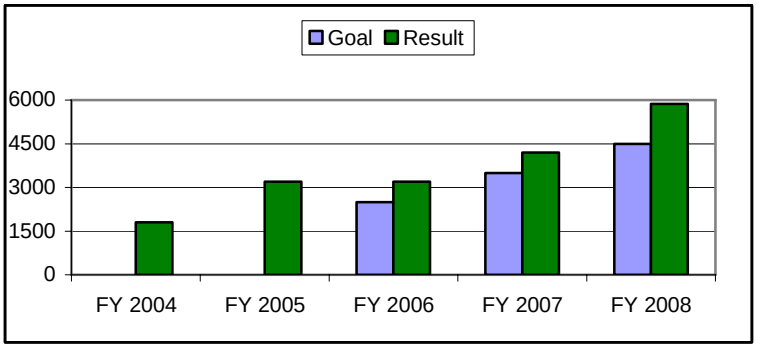
Goal: Increase the number of unique users of the Teragrid from among the science, engineering, and education community.

Program Description: The Extensible Terascale Facility, also called TeraGrid, is the world's largest, most comprehensive distributed cyberinfrastructure for open scientific research. Through high-performance network connections, TeraGrid integrates high-performance computers, data resources and tools, and high-end experimental facilities throughout the United States. TeraGrid is coordinated through the Grid Infrastructure Group (GIG) at the University of Chicago, working in partnership with the Resource Provider sites: Indiana University, the Louisiana Optical Network Initiative, the National Center for Atmospheric Research, National Center for Supercomputing Applications, the National Institute for Computational Sciences, Oak Ridge National Laboratory, Pittsburgh Supercomputing Center, Purdue University, San Diego Supercomputer Center, Texas Advanced Computing Center, and University of Chicago/Argonne National Laboratory. Access to the network is open to the science, engineering, and education community on the basis of merit-reviewed proposals. This goal tracks the number of users with unique user accounts and those who access the network through internet science gateways.

FY 2008 Result: NSF achieved this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	N/A	1800
FY 2005	N/A	3200
FY 2006	2500	3200
FY 2007	3500	4195
FY 2008	4500	5865



Agency Efforts to Improve Performance and Efficiency: Using high-performance network connections, the TeraGrid integrates high-performance computers, data resources and tools, and high-end experimental facilities around the country. Currently, TeraGrid resources include more than 750 teraflops of computing capability and more than 30 petabytes of online and archival data storage, with rapid access and retrieval over high-performance networks. Researchers can also access more than 100 discipline-specific databases. With this combination of resources, the TeraGrid is the world's largest, most comprehensive distributed cyberinfrastructure for open scientific research.

PART Evaluation: This goal was established in the Investment in Research Infrastructure and Instrumentation PART conducted in FY 2006 (PART ID: 10004405).

ANNUAL PERFORMANCE GOAL 19:
POLAR PROGRAMS: SUPPORT FOR RESEARCH IN THE ANTARCTIC

Goal: Provide the necessary research support for researchers in the Antarctic at least 90 percent of the time they are scheduled to perform research.

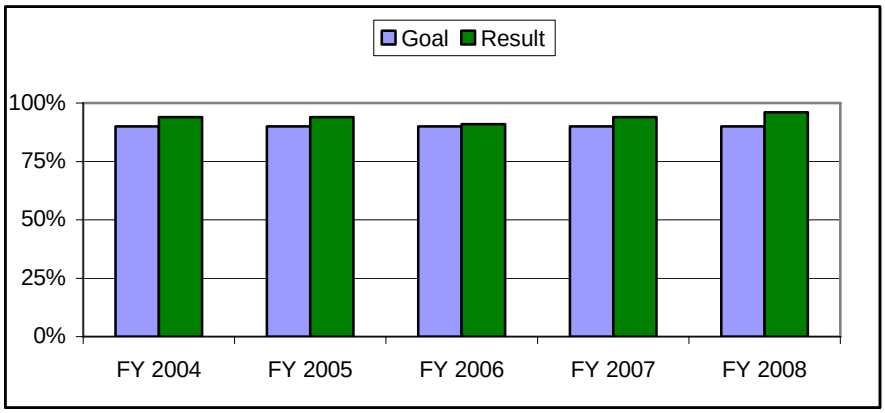
Program Description: NSF's Office of Polar Programs supports most of the research in polar regions funded by the National Science Foundation. The Antarctic is a premier natural laboratory whose extreme environment and geographically unique setting enable research on phenomena and processes not feasible elsewhere. 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.

This goal accounts for the number of days that investigators were able to conduct research at the South Pole Station because the necessary research support was provided. It excludes research conducted off site in preparation for deployment to the Pole and lost time due to circumstances beyond the program's control (e.g. severe weather). Research support for the approximately 165 current projects includes laboratory operations; facilities engineering, maintenance, and construction; communications operations; remote field camp support; cargo and passenger transportation; and housing management and janitorial services.

FY 2008 Result: NSF achieved this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	90%	94%
FY 2005	90%	94%
FY 2006	90%	91%
FY 2007	90%	94%
FY 2008	90%	96%



Agency Efforts to Improve Performance and Efficiency: The United States Antarctic program is managed by NSF with support from the primary support contractor, Raytheon Polar Services Company (RPSC). This goal is used to measure the research time for each PI while on location in Antarctica. It captures the number of operational onsite days successfully accomplished by each PI. After completing their research in Antarctica, principal investigators submit a web-based USAP Research Support Facilities Survey. RPSC is responsible for collecting data from the survey to compute the percentage of project days for which the program was able to provide the necessary support.

PART Evaluation: This goal was established in the Polar Research Tools, Facilities, and Logistics PART Program conducted in FY2004 (PART ID: 10002326).

ANNUAL PERFORMANCE GOAL 20:
POLAR PROGRAMS: CONSTRUCTION COST AND SCHEDULE

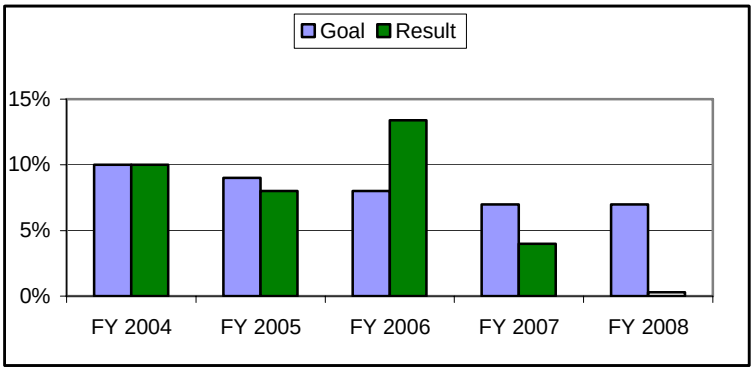
Goal: Keep the percent of cost and schedule variances for major Polar projects, as monitored by Earned Value Management, to seven percent or less.

Program Description: The goal applies to planned cost and schedule for construction projects with a total project cost of at least $5 million. Three major Polar projects are in this category: the South Pole Station Modernization, the IceCube Neutrino Observatory, and the McMurdo Power Plant. The goal result is calculated by taking an average of cost and schedule variances. The result reflects the weighted average of the three projects.

FY 2008 Result: NSF achieved this goal.

Comparison of Actual Performance with the Projected (Target) Levels of Performance:

	Goal	Result
FY 2004	10%	10%
FY 2005	9%	8%
FY 2006	8%	13%
FY 2007	<7%	4%
FY 2008	<7%	0.3%



Agency Efforts to Improve Performance and Efficiency: NSF continues to monitor cost and schedule variances at the major Polar projects.

PART Evaluation: This goal was established in the Polar Research Tools, Facilities, and Logistics PART Program conducted in FY 2004 (PART ID: 10002326).

ANNUAL PERFORMANCE GOALS 21 - 23:
K-12 MATH AND SCIENCE EDUCATION PART MEASURES
Established in FY 2008

Goals in the K-12 Math and Science Education Program

1. Minimum number of resources (instructional programs, models, or interventions) developed by the DRK-12 (Discovery Research K-12) program whose effectiveness has been examined using rigorous methods.
   FY 2008 Target: 8
   FY 2008 Result: 9
2. Percentage of development-intensive projects in the DRK-12 program that employ appropriate methods to evaluate efficacy and apply them rigorously.
   FY 2008 Target: 70%
   FY 2008 Result: 86%
3. For MSP (Math and Science Partnership Program) projects focused on mathematics, percentage of MSP schools meeting Adequate Yearly Progress (AYP) in mathematics.
   FY 2008 Target: 80%
   FY 2008 Result: 81%

Program Description: NSF's K-12 Math and Science Education Program is designed to build strong foundations and foster innovations to improve teaching, learning, and evaluation in pre-college math and science. It explicitly aims to generate research-based outcomes, develop innovative resources and tolls, and build human capacity to improve K-12 Science, Technology, Engineering, and Mathematics (STEM) learning. This PART evaluation focused on two major programs: the Discovery Research K-12 Program (DRK-12) and the Math and Science Partnerships (MSP) Program. Both are research grants programs, focusing on investigator-initiated proposals that undergo NSF's rigorous merit review process.

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FY 2008 Results: NSF met the three performance targets. Because these measures were established in FY 2008, prior year results are not available.

Projected Future Target Levels of Performance:

Goal 1: Rigorous Examination of Effectiveness of Resources in DRK-12 Program
Year: 2012 Target: 13
Year: 2017 Target: 18

Goal 2: Rigorous Evaluation of DRK-12 Development Projects
Year: 2009 Target: 75
Year: 2011 Target: 90
Year: 2014 Target: 100

Goal 3: Math & Science Partnership Schools: Adequate Yearly Progress (AYP)

Year: 2009	Target: 83%	Year: 2012:	Target: 93%
Year: 2010	Target: 86%	Year: 2013:	Target: 96%
Year: 2011	Target: 90%	Year: 2014:	Target: 100%

Agency Efforts to Improve Performance and Efficiency: NSF will initiate an independent study of the efficacy and impact of the K-12 programs, including a comparison with other relevant government and private efforts. NSF will develop and implement systems and evaluation components to ensure that all necessary information is gathered from Discovery Research K-12 awardees. NSF will engage independent evaluations of the Math and Science Partnerships program designed to demonstrate a clear causal link between this program and measured progress in student proficiency.

PART Evaluation: This goal was established in the K-12 Math and Science Education PART in FY 2008 (PART ID: 10009092).

Appendix D: Program Evaluations

D.1 Committee of Visitors Meetings Through FY 2011

DIRECTORATE/OFFICE *Division* Program or Cluster	Fiscal Year of Most Recent COV	Fiscal Year of Next COV
BIOLOGICAL SCIENCES		
Biological Infrastructure	2007	2010
Environmental Biology	2006	2009
Integrative Organismal Systems	2008	2011
Molecular and Cellular Biosciences	2008	2011
Emerging Frontiers	2006	2009
COMPUTER AND INFORMATION SCIENCE AND ENGINEERING		
Computing & Communication Foundations	2006	2009
Computer & Network Systems	2006	2009
Information & Intelligent Systems	2006	2009
EDUCATION AND HUMAN RESOURCES		
Research on Learning in Formal and Informal Settings		
Discovery Research K-12 (new in FY 2007)	N/A	2009
Informal Science Education	2008	2011
Information Technology Experiences for Students and Teachers (ITEST)	2008	2011
Research & Evaluation on Education in Science & Engineering (REESE)	2003	2009
Undergraduate Education		
Advanced Technological Education	2006	2009
Course, Curriculum, and Laboratory Improvement	2006	2009
Excellence Awards in Science & Engineering	N/A	2009
NOYCE Scholarships	2005	2009
Math and Science Partnership (MSP)	2008	2011
National SMETE Digital Library	2005	2009
STEM Talent Expansion Program (STEP)	2006	2009
Scholarships (S-STEM in FY 2007)	2007	2010
Scholarship for Service	2007	2010

Graduate Education		
GK-12 Fellows	2008	2011
Graduate Research Fellowships	2006	2009
Integrative Graduate Education and Research Traineeship Program (IGERT)	2008	2011
Human Resource Development		
Alliances for Graduate Education and the Professoriate	2007	2010
Centers for Research Excellence in Science and Technology	2007	2010
Gender Diversity in STEM Education	2006	2009
Historically Black Colleges and Universities – Undergraduate Program	2007	2010
Louis Stokes Alliances for Minority Participation	2007	2010
Program on Research in Disabilities	2006	2009
Tribal Colleges and Universities Program	2007	2010
ADVANCE Program	2008	2011
CAREER Program	2007	2010
ENGINEERING		
Chemical, Bioengineering, Environmental and Transport Systems	2006	2009
Civil, Mechanical and Manufacturing Innovation	2006	2009
Electrical, Communications and Cyber Systems	2008	2011
Engineering Education and Centers	2007	2010
Industrial Innovation and Partnerships	2007	2010
Emerging Frontiers in Research and Innovation (Created 10/1/06)	N/A	2010
GEOSCIENCES		
Atmospheric Sciences		
Lower Atmosphere Research Section	2007	2010
Upper Atmosphere Research Section	2008	2011
UCAR and Lower Atmospheric Facilities Oversight Section	2006	2009
Earth Sciences		
Instrumentation and Facilities	2007	2010
Surface Earth Processes Section		
Sedimentary Geology & Paleobiology	2008	2011
Geobiology and Low Temp Geochemistry	2008	2011
Geomorphology and Land Use Dynamics	2008	2011
Education and Human Resources	2007	2010
Deep Earth Processes Section	2008	2011
Ocean Sciences		
Integrative Programs Section		
Oceanographic Facilities	2008	2011
Oceanographic Instrumentation and Technical Service	2008	2011

GEOSCIENCES (continued)		
Ocean Education	2006	2009
Ship Operations	2008	2011
Marine Geosciences Section	2006	2009
Ocean Section	2006	2009
Other Programs		
Global Learning and Observation to Benefit the Environment	2007	2010
Opportunities for Enhancing Diversity in the Geosciences	2007	2010
Geoscience Education	2007	2010
Geoscience Teacher Training	2007	2010
MATH AND PHYSICAL SCIENCESS		
Astronomical Sciences	2008	2011
Chemistry	2007	2010
Materials Research	2008	2011
Mathematical Sciences	2007	2010
Physics	2006	2009
SOCIAL, BEHAVIORAL, AND ECONOMIC SCIENCES		
Science Resource Statistics (SRS)	2006	2009
Behavioral and Cognitive Sciences	2006	2009
Social and Economic Sciences	2007	2010
Science of Learning Centers	N/A	2009
Human and Social Dynamics	2008	N/A
OFFICE OF CYBERINFRASTRUCTURE	2008	2011
OFFICE OF INTEGRATIVE ACTIVITIES		
Experimental Program to Stimulate Competitive Research (EPSCoR)	2005	2009
Major Research Instrumentation (MRI)	2005	2010
OFFICE OF INTERNATIONAL SCIENCE & ENGINEERING	2008	2011
OFFICE OF POLAR PROGRAMS		
Polar Research Support	2004	2009
Antarctic Sciences	2006	2009
Arctic Sciences	2006	2009

Appendix D: Program Evaluations
D.2. External Evaluations

Following is a summary of the findings and recommendations of external evaluations of NSF programs published during Fiscal Year 2008. The evaluations are the results of workshops, studies, or reports commissioned by various programs in the National Science Foundation. The list is organized alphabetically by the NSF Directorate/Office that commissioned the evaluation, with evaluations commissioned by more than one Directorate/Office listed first.

	Directorate for Engineering (ENG) Directorate for Mathematics and Physical Sciences (MPS)
WTEC Workshop on Simulation-Based Engineering and Science ***April 25, 2008***	**Findings:** • Investment in algorithm, middleware, and software development lags investment in hardware, preventing the full exploitation utilization of new and even current architectures • Anticipated inability to fully exploit multicore/petaflop technology • Lack of support and reward for code development and maintenance • Timescale to develop large complex code is great, exceeding hardware lifetime • The UK, which once led in this, no longer provides support in this area • Progress in Simulation-Based Engineering and Science (SBE&S) requires crossing disciplinary boundaries • US perceived to be leaders in interdisciplinary teams • Best SBE&S students leaving science (e.g. Switzerland, computational scientists/engineers are being hired by financial sector) **Recommendations:** • Industry-driven partnerships with universities, labs to hardwire scientific discovery to engineering innovation through SBE&S • Payoff: New and better products; development savings in cost and time • Developing standards for interoperability of codes • New paradigms for education and training of the next generation (software engineering, V&V, petascale, etc.) • Long-term support of code development (and maintenance) projects for targeted problems in science and engineering • Support to community in preparing for multicore/petascale **Availability:** http://www.wtec.org/sbes/workshop/FinalWS-20080425/SBES-allpresentations-30Apr08-lowres.pdf

	Directorate for Engineering (ENG) Directorate for Biological Sciences (BIO)
Advancing Tissue Science and Engineering: A Multi-Agency Strategic Plan	**Scope:** Tissue science and engineering is dependent on a better understanding of subcellular biological pathways; this understanding in turn requires the availability of advanced technologies at the nanometer-, micrometer- and meso-scales. Tissue science and engineering applications will include medical therapeutics and highly innovative non-medical applications. As a result, it is appropriate to understand how tissue science and engineering contributes to or benefits from other Federal initiatives such as the National Nanotechnology Initiative, the National Institutes of Health (NIH) Roadmap, the FDA Critical Path Initiative, and the Medical Innovations Report. **Findings:** Leadership from the Federal agencies involved in tissue science engineering will be required if the United States is to: • Set the standards for the efficient and effective management of tissue science and engineering research and products • Maintain U.S. scientific and engineering preeminence in this field and ensure that the potential of this promising technology is fulfilled • Support the national research priority of developing a deeper understanding of complex biological systems, which requires collaborations among physical, computational, behavioral, social, and biological scientists and engineers • Capture the potential benefits to society from both medical and non-medical applications of tissue science and engineering **Recommendations:** ***Strategic Priority 1: Understanding the Cellular Machinery*** Obtain a molecular-level understanding of the physical, chemical, and biological conditions that direct cells to assemble into and maintain complex communities and functional 3D tissues. ***Strategic Priority 2: Identifying, Validating Biomarkers and Assays*** Identify biomarkers that can be used to specify cells in tissue-engineered constructs, assess their physiological state and/or condition such as their state of differentiation. Develop high-throughput, high-content assays for collecting multiparametric data and correlating that information with biologically significant outcomes. ***Strategic Priority 3: Advancing Imaging Technologies*** Develop high-resolution, non-destructive imaging technologies to assess

	engineered tissue function *in vivo* and *in vitro* in real time. ***Strategic Priority 4: Defining Cell/Environment Interactions*** Develop design principles for new materials based on a physical and quantitative understanding of how cells respond to molecular signals and integrate multiple inputs to generate a given response in their physiological environment. Test new matrices for biocompatibility and successful integration into relevant hosts or *in vitro* platforms. ***Strategic Priority 5: Establishing Computational Modeling Systems*** Make available user-friendly, predictive (physiological, biological, and mechanical) computational models whose simulations will aid in the engineering of reproducible tissue constructs. ***Strategic Priority 6: Assembling and Maintaining Complex Tissue*** Develop novel tools and bioreactors to precisely control rapid stem/progenitor cell expansion as well as the chemical and mechanical environment for phenotype-directed 3D tissue growth and function. ***Strategic Priority 7: Improving Tissue Preservation and Storage*** Optimize methods for long-term, low-cost, low-maintenance preservation that allow recovery of viable and functional cells/tissues. Develop better storage, shipping, and packaging techniques to provide tissues on demand. ***Strategic Priority 8: Facilitating Effective Applications Development and Commercialization*** Facilitate cost-effective production and scale-up of tissues and organs that can effectively meet regulatory requirements for good manufacturing practices and meet aggressive cost-benefit targets for a wide variety of applications. Availability: http://tissueengineering.gov/welcome-s.htm

	Directorate for Engineering (ENG) Directorate for Biological Sciences (BIO)
Report from the US-EC (European Commission) Workshop on Infrastructure Needs of Systems Biology	**Findings:** Systems biology is in a state of rapid development, characterized by an inability of the infrastructure to keep up with the demands of the science. **Recommendations:** <u>Experimental Tools</u> • Support the joint creation of common experimental protocols, selection of truly validated common cell types, tools for single cell analysis, globally useful reagents, reporter constructs, etc., thus making experimental data more valuable for modeling. • Make established experimental techniques broadly available to the community. • Create a large-scale proteomics effort which would include alternative modifications, localization, structure, etc. <u>Databases</u> • Establish criteria for long-term support for systems biology relevant databases. • Support the development of standard representations enabling interoperability between databases and tools. • Support data capture incorporating minimal information, using standard formats and semantics. • Support and broaden BioMart-like data integration schemes going beyond sequence centric approaches. • Promote access to full-length paper text and repositories and promote semantic enrichment efforts. • Support 'workflow' schemes in the context of systems biology. <u>Models, Modeling, and Software</u> • Support initiatives in multi-scale modeling spanning molecular to multi-tissue organism levels. • Support the use of standards and environments that permit interoperability and integration. • Initiate an infrastructure-related software support mechanism in the EC (like in the US). • Support systems biology software repositories which incorporate software curation. • Support education in the use of software within systems biology. <u>Organization and Education</u> • Support education in the use of software within systems biology. • Initiate US-EC collaboration on establishing curricula in systems biology. • Support activities similar to competitions like Internet Genetically

	Engineered Machine Competition (iGEM) (see www.igem2007.com). • Support community building around concrete projects, e.g., ontologies and databases, funded jointly by the US-EC. In effect international glue-grant funding. • Establish joint US-EC panels for assessment of research projects. • Joint US-EC systems biology benchmark studies such as A European Network of Excellence (ENFIN-DREAM) www.enfin.org/dokuwiki/doku.php?id=wiki:wp7 and http://magnet.c2b2.columbia.edu/news/DREAMInitiative.pdf). This could possibly include funding for pre- and post-prediction experimental data generation, evaluation, and creation of standards. • Generate procedure for US involvement in European Strategy Forum on Research Infrastructure (ESFRI). Specific Recommendations for Prompt Action • Create a mechanism to support ongoing joint US-EC benchmark efforts with special emphasis on data generation. • Start effort on standards and interoperability for databases, software, and experimental systems. • Exchange information on training programs. **Availability:** http://ec.europa.eu/research/biotechnology/ec-us/docs/us_ec_syst_biology_workshop.pdf

	Directorate for Engineering (ENG) Directorate for Biological Sciences (BIO)
U.S.-Europe Workshop on BioSensing & BioActuation: Interface of Living & Engineered Systems ***July 2008***	**Findings:** The NSF-ESF BioSensing and BioActuation Workshop, held June 15-17, 2008 in Taormina, Italy, brought together leading trans-national researchers, including 20 from the US and 35 from Europe, with a common interest in multi-disciplinary research on biologically inspired sensors, actuators and engineering systems. Program officers representing the ESF, NSF and AFOSR were present. Participants in the workshop discussed the current state-of-the-art in both the biology and engineering communities specifically highlighting the current needs, capabilities, grand challenges and collaborative opportunities surrounding biologically inspired sensors, actuators and engineering systems. The group was charged with developing a vision of the science and engineering research opportunities and revolutionary biosensing and bioactuation capabilities including formulation of the broader context and transformative advances gained through this cross-disciplinary US-European collaboration. Strong synergies for collaboration were found among the participants. Four major interdisciplinary research grand challenges were identified that will maximize the impact of the cross-disciplinary bio-derived and bio-inspired research initiatives and technologies envisioned by the workshop participants. The realization of these challenges will lead to fundamental new discovery and significant advances in science and engineering. **Recommendations:** • A compelling new research frontier exists in the basic science and engineering of biologically inspired sensors, actuators and engineering systems which will form the basis for revolutionary bio-derived and bio-inspired technologies. • Tremendous opportunities exist for synergistic ESF-NSF cooperative research on the transformational science and engineering pertaining to biologically inspired sensors, actuators and engineered systems including strengthening our basic understanding of these systems and societal outcomes derived from related technological advances for the environment, health, security and energy. • NSF and ESF should strengthen existing bonds and build new ties facilitating US Europe interactions, synergies and strengths by supporting this multi-disciplinary research initiative. • Financial resources to support these initiatives should be developed and committed. **Availability:** http://www.esf.org/research-areas/physical-and-engineering-sciences/us-europe-workshop-on-biosensing-and-bioactuation-interface-of-living-and-engineered-systems.html

	Directorate for Engineering (ENG) Directorate for Geosciences (GEO) Directorate for Social, Behavioral, and Economic Sciences (SBE)
Effectiveness of the National Earthquake Hazards Reduction Program: A Report from the Advisory Committee on Earthquake Hazards Reduction ***May, 2008***	**Findings:** While the Advisory Committee on Earthquake Hazards Reduction (ACEHR) was concerned about the limitations for funding for the National Earthquake Hazards Reduction Program (NEHRP), it found that NEHRP has achieved significant improvements, notably in its restructuring and broader collaborative efforts, since the 2004 reauthorization by Congress. NEHRP is committed to, and has made progress towards becoming a fully effective, collaborative, and focused program to protect the Nation against unacceptable risks from seismic hazards. NIST, as the newly designated lead agency for NEHRP, has formed a NEHRP office with a highly regarded director. Each of the other agencies including NSF has a significant role in NEHRP, with the active participation of each agency's director. NEHRP is responsible for ensuring earthquake risk reduction opportunities are made available to vulnerable communities. This responsibility ranges from conducting basic research to transferring research results into cost-effective mitigation. The overall success of NEHRP is highly dependant on legislative and administrative support for increased funding. To protect society against catastrophic earthquake-induced losses, NEHRP must become a well-recognized national priority. Risk reduction actions must be taken at the national, state, and local levels. This includes full funding of FEMA programs for the types of state-level programs that could lead to the creation of effective response plans to facilitate the immediate and long-term recovery process in the aftermath of a severe earthquake. In regard to the mission of NSF, fundamental research in earth science, engineering, and social science is critical to advancing our knowledge and should be fully supported in the context of NEHRP. It is equally critical to transfer research findings into practice. Without integrative research into the political, social, and economic circumstances that motivate society to achieve community resilience, implementation of proven earthquake resistant retrofit strategies will fall short. Sufficient attention is not being paid to the development of national standards for lifelines and existing buildings that will provide a resilient built environment. **Recommendations:** • NSF should enhance its support for multidisciplinary research related to NEHRP, which can be used as a model for reducing risks associated with other natural and human-induced hazards. In particular, there is an opportunity for the Engineering and

	Geosciences Directorate to partner with the Social, Behavioral, and Economic Sciences Directorate to understand the social and economic factors that promote mitigation measures • NSF should enhance its support for curiosity-driven basic research, which has been the foundation of many important technical discoveries. Basic research sponsored by NSF educates the next generation of engineers and scientists engaged in earthquake risk reduction. Such support is thus a means of expanding the workforce in earthquake engineering and science. **Availability**: http://www.nehrp.gov/pdf/2008ACEHRReport.pdf

	Directorate for Biological Sciences (BIO)
Where to Next with The Tree of Life? Workshop Report	**Scope:** To consider the nature of the tree of life, phylogenomics, horizontal gene transfer, and developmental evolution in the context of the Tree of Life program, and to provide perspectives on the future of the Tree of Life program. **Findings:** The Tree of Life program has had significant success in its first decade. Major branches have been explored and progress has been made in reconstructing the history of life. A number of areas, addressed in the Recommendations below, should be considered in the future of the program. **Recommendations:** A number of recommendations were made including: • Microbial diversity need broader representation on the tree of life. • Horizontal gene transfer is an important process that should be incorporated into tree of life research. • Better coordination between project teams will ensure that the phylogenetic information gathered by individual groups can be integrated into a comprehensive Tree of Life. **Availability**: Forthcoming

	Directorate for Biological Sciences (BIO)
2020 Vision for Biology: The Role of Plants in Addressing Grand Challenges in Biology	**Scope:** A group of scientists from the United States, Europe and South America discussed the progress of this program and charted the future directions for the field. **Findings:** The workshop participants concluded that during the last 20 years Arabidopsis has emerged as the primary experimental system for essentially all aspects of plant biology. By focusing on a single tractable system, the international Arabidopsis community has made dramatic advances in nearly every area of plant research. Further, because of the close evolutionary relationships between all flowering plants, discoveries in Arabidopsis have been readily translated to other plant species such as economically important crops. In addition, discoveries made in Arabidopsis have impacted research in animal systems including disease processes in human. The remarkable success of Arabidopsis research is partly the result of wise investment by the NSF, first through the Arabidopsis Genome sequencing program and attendant technology development and subsequently via the Arabidopsis 2010 Program. This project, now nearing its completion, has funded the generation of a broad range of powerful genetic and genomic resources and technologies. The Arabidopsis toolbox, together with the unique qualities of Arabidopsis and allied species, will now facilitate effective studies at all levels of biological organization including, molecular, cellular, organismal, and ecological. In addition, the Arabidopsis 2010 Program has fostered the development of a vigorous and dynamic international community of researchers, a process that has included the training of many graduate students and postdoctoral researchers, and recruited many scientists not trained initially in plant biology. Because of this investment, the Arabidopsis research community is ideally, and uniquely, positioned to address the Grand Challenges in biology as described below. A true systems biology approach, encompassing all of life's components from molecules to populations, is now possible using Arabidopsis. **Recommendations:** • Funding agencies should continue to provide major and specific support to integrate molecular, cellular, organismal, and ecological research on Arabidopsis as a system to understand how a living organism develops, functions and adapts to its environment. • Funds should be provided for development of additional and new types of large-scale experimental genomics resources that will be required to effectively address the Grand Challenges.

	• Efforts should be made to encourage the development of new quantitative approaches to the study of biological systems using Arabidopsis and allied species. This should involve the development of collaborations between biologists, mathematicians, computer scientists, engineers and scientists in other quantitative disciplines. • Data acquisition should remain a major focus of future programs to fuel iterative cycles of data analysis, integration, hypothesis generation and testing. The emergence of new technologies will enable the collection of new and higher quality data of all types, thus permitting more sophisticated systems analyses. Availability: http://arabidopsis.org/portals/masc/workshop2020.pdf A workshop summary was published by Natasha Raikhel in the journal Molecular Plant (http://mplant.oxfordjournals.org/cgi/content/full/1/4/561) *Reference: Mol Plant 2008 1: 561-563; doi:10.1093/mp/ssn040*

	Directorate for Education and Human Resources (EHR)
The Federal Cyber Service: Scholarship for Service (SFS) Program – Summative Evaluation Report ***Abt Associates January 2008***	**Scope**: This SFS final report is for a three-year evaluation of the SFS program conducted by the Assessment Services Branch of the Division for Human Resources Products and Services, U.S. Office of Personnel Management (OPM), for the National Science Foundation, Division of Undergraduate Education. The evaluation centers around the following questions: 1. How well is the SFS program delivered? Are the necessary supports established and effective? 2. How extensive is the demand for IA professionals in the Federal Government and what are the opportunities for graduates of the SFS programs? 3. How effective is the SFS program? 4. Have desired program effects occurred (e.g., high quality candidates, retention for 2 years in Government jobs)? **Findings**: Results of the third-year SFS program evaluation are encouraging. The overall finding suggest a generally well-implemented program with a number of clear successes in achieving important goals. Note that a comparison of results across multiple years also indicates improvement. Overall satisfaction with the program was high, according to 95 percent of PI/faculty survey and 84 percent of student respondents. Student Quality: More than two-thirds of SFS students had entry GPAs above 3.5, indicating that the program attracts high-quality students. Most supervisors of SFS interns/employees (89 percent) reported satisfaction with the overall quality of SFS graduates. Capacity Building: Most PIs agreed that the SFS program has improved their department's reputation (81 percent) and increased their department's visibility (96 percent). More than two-thirds of students were satisfied with the opportunity that internships provide for on-the-job training and to apply classroom learning. Most SFS graduates agreed that mentoring had contributed to their job-career success (72 percent) and likelihood of remaining in the information security field (71 percent). Placement and Retention: As of September 2007, the cumulative job

	placement for graduates was at 88 percent. Survey results for SFS graduates indicate that 74 percent are still working in the same Federal agency in which they began to fulfill their employment obligations. Other notable findings are that the funding of the program is sufficient and distributed fairly, focus groups and survey results indicate that some universities have adopted best practices in preparing SFS students, and continue to adhere to the current undergraduate and graduate stipend levels. **Recommendations**: Within the evaluation, recommendations are made under the following areas: Marketing: Leverage the SFS website more effectively to inform agencies of program benefits. Agency representatives could be directed to the SFS website via announcements on Federal IA subscription electronic mailing lists and advertisements in Federal IA publications. Administration: NSF needs to modify the program solicitation to maximize the percentage for management and administrative costs from 15 percent to 20 percent, and to include a requirement for an external evaluator to assess program outcomes. OPM and NSF need to clarify the SFS contract regarding the responsibilities of students. OPM needs to develop a manual outlining all the rules, regulation and expectations of the program. **Availability**: United States Office of Personnel Management (OPM). (2008). *Summative Evaluation Report: The Federal Cyber Service: Scholarship for Service Program.* Washington, DC: OPM Division of Human Resources Products and Services.

	Directorate for Education and Human Resources (EHR)
Evaluation of the Faculty Early Career Development (CAREER) Program: Final Report ***Abt Associates*** ***June 2008***	**Scope**: This study assesses the longer-term impacts of a CAREER award on awardee's professional advancement, research productivity, and engagement in integration. The evaluation was designed to answer four questions: 1. How do stakeholders at NSF perceive the CAREER program and its relationship to the mission of NSF? 2. What is the impact of CAREER on the research activities and career advancement of awardees? 3. What is the impact of CAREER on the integration of research and education by awardees? 4. How do faculty members in department that host CAREER awardee(s) view the CAREER program and its relationship to their research and education missions? **Findings**: 1. The majority of the NSF program officers interviewed describe the CAREER program as a highly successful effort to support the early careers of STEM faculty members. A small minority of program officers commented that the structure of the CAREER program was misaligned with the mission of research in disciplines where new researchers do not have significant educational responsibilities. 2. The most common reasons cited by active CAREER awardees for applying to the CAREER program were CAREER's importance in tenure review (78 percent) and CAREER's prestige (66 percent). All CAREER awardees report positive benefits from their CAREER award for their own professional development (98 percent), with 50 percent valuing the opportunity to pursue new research topics. 3. Sixty percent of active CAREER awardees cited alignment between CAREER's emphasis on integrating research and education and their own goals as one of the reasons they applied for CAREER funding. Additionally, forty three percent of awardees noted that CAREER provided them with an opportunity to pursue an educational activity that subsequently benefited their research. 4. Though CAREER awardees are the direct beneficiaries of the Faculty Early Career Development Program, departments

	may also derive benefit from the presence of awardees. Having a CAREER awardee on faculty might enhance the prestige of the department and encourage other junior faculty to apply. This evaluation suggests that the presence of CAREER awardees in a department has a far stronger impact on the research side of the university culture than on the education and integration side. While having a CAREER award is not a requirement for tenure, 93 percent of department chairs agreed that winning a CAREER serves as an important factor in the promotion process; the CAREER award is viewed as an external endorsement of the quality of the PI's research. 5. Sixty-two percent indicated that tenure review committee members had specifically mentioned the CAREER grant as a positive factor in the decision process. 6. Winning a CAREER award does not increase time that awardees spend on education, but awardees report that it did change their interest in or focus on educational activities. **Questions for Further Study**: 1. Should PECASE awardees be selected solely from among CAREER awardees? 2. Should the minimum award size be set agency-wide or allowed to vary among individual directorates? 3. Is it sufficient for awardees (and by extension, their institutions) to "integrate" research and education by pursuing excellence in each domain separately, or must awardees pursue a unified research and education agenda in which these two domains are interdependent, such that the activities in one could not advance without activities in the other domain? 4. At what level(s) – graduate, undergraduate, or K-12 – should awardees be targeting the development of integrated research and education agendas? 5. What activities count as integration of research and education? 6. How accountable should CAREER awardees be for conducting and reporting to NSF on the outcomes of their proposed education and integration activities? **Availability**: Carney, J., Smith, W., Parsad, A., Johnston, K. and Millsap, M. (2008). *Evaluation of the Faculty Early Career Development (CAREER) Program.* Bethesda, MD: Abt Associates, Inc.

	Directorate for Education and Human Resources (EHR)
Evaluation of the Teacher Professional Continuum: Final Report ***Abt Associates*** ***October 31, 2008***	**Scope**: In 2005, NSF contracted with Abt Associates to perform an evaluation of the portfolio of projects funded by the TPC program. The evaluation was understood to be focused on the portfolio's success in implementing the major foci in the solicitations from FY03 through FY05. Among the study questions the evaluation was designed to answer were the following: 1. How are the TPC resources allocated? 2. What are the characteristics of the TPC portfolio? 3. How successful has the TPC portfolio of grantees been in meeting the goals of the TPC program? 4. What have been some of the challenges or barriers in addressing the program goals? How have the projects overcome barriers or challenges? 5. What have been some of the facilitating factors in addressing the program goals? 6. To what extent has the TPC program shifted the focus of the field from practice to research? The Abt Report notes on Page V of the Executive Summary: "Given that most of the research and resource projects on which this evaluation focuses are still in progress, a challenge was assessing outcomes, products, and contributions of the projects based on information provided in projects' reports to NSF. Few of the four-year studies and none of the five-year studies funded in 2003 (the first funding year) had submitted final reports by the Fall of 2007 when the final set of data were collected for this evaluation." Based on an analysis of the program goals, using 121 projects, stated in the TPC solicitations, Abt Associates constructed unified statements on the program's primary goals and elaborated indicators for them. The seven goals upon which the TPC program was evaluated (and on which findings and conclusions are later enunciated) are: 1. Advancing the knowledge base on the recruitment, preparation, induction, enhancement, and retention of STEM teachers, and on strategies that strengthen and diversify the STEM teaching workforce. 2. Promoting scientifically based research that examines teacher learning of STEM content and pedagogy, and

	assesses the subsequent impact of this learning on practice. 3. Encouraging research on effective professional development models and experiences that enhance STEM teachers' pedagogical content knowledge and its alignment with classroom practice. 4. Understanding, through research, those instructional practices that enhance student learning in STEM disciplines. 5. Developing innovative resources, materials, tools, and ideas, for preparing and supporting STEM teachers and those who educate them. 6. Fostering effective collaborations between the communities of STEM K-12 teachers, STEM researchers, practitioners, and others contributing to STEM education. 7. Disseminating research findings, effective models, and field-tested resources to national audiences of practitioners, administrators, researchers, policy makers, education faculty, and STEM disciplinary faculty. **Findings**: The following conclusions can be drawn about the success of the TPC program in achieving the seven goals enumerated above: Goal 1: The portfolio of TPC projects is contributing to confirming and strengthening the knowledge base on teacher preparation and enhancement in mathematics and science. More than half of the research activity targeted middle and high school mathematics and science. Additionally, 61 percent of the projects focused on teaching pedagogy. Goal 2: The TPC program was successful in funding a large number of research and research-intensive resource projects to conduct scientifically based research that examines teacher learning of STEM content and pedagogy. Specifically, 77 percent of the 58 research projects and all 11 of the research-intensive resource projects asked at least one research question about the impact of an intervention on teacher and student outcomes. Goal 3: A number of projects used different professional development models in their research and strove to enhance teachers' pedagogical content knowledge, and study its alignment to classroom practice. Goal 4: Approximately half the projects in the TPC portfolio intended to measure student outcomes. Given that project interventions can first be expected to influence teachers before they

	influence students, it is likely that some projects will produce results related to student outcomes as they get closer to completion. Goal 5: The program was successful in encouraging resource projects to produce a wide range of resources for teachers and other education professionals using a variety of media. The majority (89 percent) of the resource projects created materials and resources for teachers and almost one-third (30 percent) targeted professional development providers. Goal 6: The program was successful in encouraging the majority of TPC projects to establish partnerships and collaborations with individuals and organizations with which they had not worked before. The types of organizations that projects most commonly cited as partners or collaborators were school districts, schools, college/university departments and centers, and research organizations. Goal 7: Although many TPC projects are still in the early stages of project work, approximately one-third has been active in disseminating information about their work to a wide variety of audiences. Yet, it is reasonable to expect that as TPC projects mature and produce research-based and evaluation outcomes, they will disseminate results that contribute to advancing the knowledge base. **Recommendations**: Goal 1: Projects' peer-reviewed publications be reviewed, as journal articles are the primary vehicle for sharing project results and the methods employed to achieve the results. Goal 2: Develop/provide the projects/reviewers with summary guides that list the conditions that different types of designs and analyses must meet to be considered rigorous. Have projects map their research questions to their designs and analyses in a summary table. Commission a project to review and compile existing research instruments, assess their reliability and validity, cite studies in which they have been used, and make results available on a dynamic, easily updateable website. Goal 3: Studies be funded that are designed specifically to assess the efficacy of different models in enhancing all three components of pedagogical content knowledge.

	Goal 4: Have a competition for, or commission studies, that are designed specifically to assess the impact of fully implemented teacher professional development activities on student outcomes. Goal 5: Assess the efficacy of the resources that were developed, by: the degree to which they are used and adopted; and the impact they have on their target audience. Goal 6: Define *partnership, collaboration, and contact* in its annual report form to ensure that PIs respond to the items as intended. Provide more specific guidelines to PIs about where in their annual reports it wants PIs to discuss their collaborations and the type of information it wants PIs to provide about the nature and effectiveness of the collaboration. **Availability**: Lovitts, B., Bobronnikov, E., Breaux, G. and Lauman, B. (2008). *Evaluation of the Teacher Professional Continuum Program Portfolio*. Bethesda, MD: Abt Associates, Inc.

	Directorate for Engineering (ENG)
Workshop: Healthcare Engineering and Health Services Research: Building Bridges, Breaking Barriers	**Findings:** Few would dispute that the rapidly escalating cost of health care is one of the most pressing issues facing our nation today. Even a cursory review of the media reveals intense public concern over a healthcare system that can use the most advanced technology to miraculous therapeutic effect, but whose emergent behavior is far from ideal. Rapidly rising healthcare costs threaten the competitiveness of U. S. manufacturing and service companies in the global economy, creating intense pressure to move offshore. Indeed one can make the case that the best way to help competitiveness prospects for U. S. industries, as a whole is to improve healthcare delivery. **Recommendations:** • The National Science Foundation (NSF) should adopt the application of science and engineering to improving the healthcare delivery system as one of its missions, representing and supporting the engineering community in its efforts to contribute to what is possibly the most important societal problem of our time. • NSF should create interdisciplinary engineering and science initiatives that complement current "translational research programs" in the NIH and "evidence-based programs" in AHRQ. • NSF should encourage doctoral students, post-doctoral students, and junior faculty to take up careers in this area by providing Graduate Fellowships and early career funding. • NSF should direct substantial research in the behavioral sciences towards understanding the problems of effective collaboration between scientific, engineering, clinical and health services disciplines. • NSF should reach out to other government agencies such as the Veteran's Administration, the Department of Defense, and the National Institutes of Health to establish a long-term, interdisciplinary funding program directed explicitly at the healthcare delivery system. • NSF should provide funding opportunities for engineering schools to develop long-term collaborative relationships with academic medical centers (such as the Veteran's Administration) to form a living laboratory for the multidisciplinary study of problems of importance to national health policy that extend systems engineering methodology. • As part of its funding opportunities NSF should encourage the study of international health systems and collaboration with international investigators to develop sound options for a health care delivery system design in the U.S. **Availability:** http://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1068&context=rche_rp

	Directorate for Engineering (ENG)
Research Experiences for Undergraduates (REU) in the Directorate for Engineering (ENG): 2003-2006 Participant Survey ***A Draft Report to the National Science Foundation*** ***SRI International, August 2008***	**Scope:** ENG has two major award types for REUs -Site and Supplement awards. ENG wanted a comparison of REU Sites funded by the Division of Engineering Education and Centers ("EEC Sites"), REU Supplements funded by Engineering Research Centers ("ERC Supplements"), and REU Supplements funded by other divisions within ENG ("ENG Supplements"). In addition, ENG wanted the study to assess differences among respondent groups (undergraduates and faculty mentors) and, for undergraduates, differences by sex and race/ethnicity. The study is being conducted through two surveys. This report describes the initial survey of faculty and undergraduate participants in all EEC Sites and ERC Supplements during FY 2003 through FY 2006 and ENG Supplements during FY 2006, which was conducted during fall 2007. A follow-up survey of the FY 2006 undergraduate participants is planned for fall 2009 to measure the longer-term impact of their REU experiences. The initial survey focused primarily on specific REU experiences during the summer or the academic year but also asked about other undergraduate research experiences and about academic and career decisions. The follow-up survey will cover all undergraduate research experiences, as well as academic and career decisions. **Findings:** Research experiences for undergraduates had a variety of significantly positive effects on the undergraduates who participated in them, including gains in awareness, confidence, skills, and understanding; increased interest in related careers; and raised academic expectations. There were only slight differences in gains in awareness, confidence, skills, and understanding and no differences in increased interest in related careers or raised degree expectations across the three award types. Among the several racial/ethnic groups, Hispanics were the most likely to report these various positive effects. There were no reliable differences in effects between men and women. Undergraduates who were motivated to participate in research because they wanted help with career decisions, had enthusiasm for research, or had prior personal contact with researchers showed the highest gains in awareness, confidence, skills, and understanding. Those involved in a variety of research-related activities, who had adequate time with a research mentor, and who gained increasing independence over the course of the research also showed higher gains in these areas. Undergraduates who indicated a higher increase in confidence and awareness as a result of their research experiences also showed increased interest in a career in engineering or research and were more likely to obtain a PhD.

	Recommendations: To come after completion of follow-up survey of the FY2006 undergraduate participates in fall 2009 which will measure the longer-term impact of the participants REU experiences. **Availability:** http://www.sri.com/policy/csted/reports/university/

	Directorate for Geosciences (GEO)
NSF Workshop: Community Sedimentary Model for Carbonate Systems ***February 2008***	**Scope:** An NSF-sponsored workshop on carbonate systems and numerical systems modeling was held in late February, 2008, at the Colorado School of Mines. The purposes of the workshop were to identify grand challenges for fundamental research on ancient and recent carbonate systems, and to identify promising areas for advancing the next generation of numerical process models to enhance our ability to meaningfully and accurately model carbonate systems. Developing predictive models of carbonate systems has important implications for monitoring and managing global climate change affecting societies around the world. Carbonate sediments and rocks form an important part of the global carbon cycle. More than 80% of Earth's carbon is locked up in carbonate rocks. Almost all of the remainder is in the form of organic carbon in sediments. About 0.05% of Earth's carbon is present in the ocean in the form of the carbonate and bicarbonate ions and dissolved organic compounds, whereas 0.0008% is tied up in living organisms, and about 0.002% is in the form of CO_2 in the atmosphere. Carbonate rock is the primary ultimate sink for CO_2 introduced into the atmosphere. **Findings:** Short- and long-term goals were identified for five areas. 1. Physical controls on carbonate deposition. 2. Biological controls on carbonate deposition. 3. Diagenesis. 4. Numerical modeling strategies. 5. Tools needs and development. **Recommendations:** The grand research challenges for advancing understanding of modern and ancient carbonate systems identified in this first integrated community workshop include: 1) Quantitatively understanding and modeling facies heterogeneities developed over various timescales, as influenced by changing biotic, paleoceanographic, paleoclimatic, and sea level conditions; 2) understanding the appropriateness of using Holocene tropical shallow-water reefs as analogues for ancient carbonate buildups; 3) developing predictive numerical simulations of diagenetic history from the scale of the pore to the scale of the platform by incorporating and coupling sedimentation, chemical and biological alterations on the seafloor, mechanical overprints, and chemical alterations resulting from fluid flow;

	4) resolving cyclostratigraphy to the 0.02-0.4 my level using high resolution biostratigraphy and absolute age dates; A more coordinated research effort in carbonate systems would be beneficial to advancing these community challenges. The group recommended research that focuses on identifying a limited number of sites to conduct integrated research on selected key subsets of: (1) the modern to Pleistocene, to examine the effects of ocean conditions and climate change on carbonate sedimentation, and the evolution of sediments into beds and strata; and (2) important analog field areas that combine outcrop, behind outcrop, and the subsurface, to build a new generation of 3-D carbonate system models. **Availability:** http://csdms.colorado.edu/meetings/carbonates_2008.html

	Directorate for Geosciences (GEO)
Origin and Evolution of Earth: Research Questions for a Changing Planet	**Scope:** At the request of the DOE, NSF, USGS, and NASA, the National Academies established a committee to propose and explore grand Earth science questions being pursued today. The research questions cover a variety of spatial scales and temporal scales, from subatomic to planetary and from the past (billions of years) to the present and beyond. **Findings:** Ten grand research questions are identified and discussed. 1. How did Earth and other planets form? 2. What happened during Earth's "dark age" (the first 500 million years)? 3. How did life begin? 4. How does Earth's interior work, and how does it affect the surface? 5. Why does Earth have plate tectonics and continents? 6. How are Earth processes controlled by material properties? 7. What causes climate to change – and how much can it change? 8. How has life shaped Earth – and how has Earth shaped life? 9. Can earthquakes, volcanic eruptions, and their consequences be predicted? 10. How do fluid flow and transport affect the human environment? **Availability:** DePaolo, D.J., et al., Origin and Evolution of Earth: Research Questions for a Changing Planet, National Academies Press, 137 p., 2008.

	Directorate for Geosciences (GEO)
Comparative Analysis Of Marine Ecosystem Organization (CAMEO): Advancing Fundamental Understanding of Marine Ecosystem Processes as a Foundation for Living Resource and Habitat Management ***A Prospectus***	**Findings:** A conceptual framework for comparative analysis of marine ecosystems involves selecting appropriate ecosystem types that are comparable in terms of structure and function, drivers of change and variability, and characterization of socially relevant properties of ecosystems. The scientific challenge for CAMEO is to use comparative analysis of marine ecosystems in innovative ways in concert with experimental, modeling and data assimilation approaches to elucidate: • How the provision of goods and services by ecosystems with different characteristics responds to natural and anthropogenic pressures and drivers of change; • Limits to ecosystem resilience, and thresholds that, when crossed, lead to phase or regime shifts, and the nature of reversibility of such shifts; • Relative performance of different management "treatments" (such as marine protected areas) by comparing similar ecosystems or sub-ecosystems subjected to different treatments; • Relationships between the human dimension of ecosystems, drivers of change, and the willingness and ability to apply management alternatives; and • Ways of translating scientific knowledge into scientifically based decision support tools that policy makers and managers need and will use. **Recommendations:** <u>Initial priorities</u> • Development of strategies and methodologies for comparative analyses, including modeling frameworks that can be applied consistently across ecosystems, and that facilitate design of decision support tools. • Modeling studies focused on specific concepts, such as connectivity, resilience or thresholds. • Retrospective studies that analyze or re-analyze or synthesize existing information (historic, time-series, ongoing programs, etc.) using a comparative approach. • Short-term empirical studies based around existing or proposed observation systems designed to "demonstrate" how such a system could be leveraged towards ongoing comparisons. • Short-term pilot projects to allow groups of investigators to organize and design larger programs. <u>Agency action</u> • Workshops to further develop aspects of human dimensions in comparative analyses, harmonizing social science and natural science approaches and concepts, and to foster formation of interdisciplinary research teams;

	• Establishment of a CAMEO program office and scientific steering committee to oversee the program, guide preparation of a “grand strategy” for comparative analyses, and synthesize program results across projects. **Availability:** http://cameo.noaa.gov/documents/CAMEO_prospectus_FINAL_020408.pdf

	Directorate for Geosciences (GEO)
NSF/NIEHS Centers for Oceans and Human Health and the NOAA Oceans and Human Health Initiative, Joint Annual Meeting, April 16-18, 2008	**Scope**: The report highlights research accomplishments and discussions for the future in the cooperative Oceans and Human Health programs (started in 2004) of the three agencies. **Findings:** Discussions and formal presentations at the meeting concerned the accomplishments of the OHH program and the identification of problems and issues that remain to be resolved. The eight presentations include discussions of the implications of climate change for human health and the impact of climate change on the oceans. They continue with a summary of the integrated ocean observing system and some examples of the use of ocean observations to safeguard human health. The conundrums of identifying suitable indicator organisms and associated monitoring strategies to ensure that coastal waters are safe for recreational use are outlined. Scientists present a progress report on the development of a high-throughput antibody-based assay for the detection of toxins in fish and shellfish. Finally, discusses research issues and problems are discussed that in the future may warrant greater emphasis in the OHH program. One of the important accomplishments of the OHH program has been the synergistic collaboration of scientists within centers and between centers. The result has been considerable leveraging of the funding to the centers and a scientific output that exceeds in important respects the results of traditional grants to individual investigators. Examples of this scientific synergism have included, inter alia, a textbook on Oceans and Human Health and a collaborative study of the impact of Hurricane Katrina on water quality in Lake Pontchartrain. These proceedings provide a good sense of the accomplishments of the OHH program and of the challenges and opportunities of the interdisciplinary science of oceans and human health. **Recommendations:** No over-arching recommendations beyond those in the various report chapters. **Availability:** http://www.prcmb.hawaii.edu/ohh2008.final.high.pdf

	Directorate for Geosciences (GEO)
External Review of the R2K Program	**Scope:** The NSF convened a panel of experts to consider the accomplishments of the R2K program to date and the future of R2K in its culminating few years. **Findings:** The accomplishments and trajectory of the RIDGE 2000 (R2K) program have been excellent. The program has achieved the following major goals: - Carried out comprehensive multi-disciplinary studies at two Integrated Studies Sites (ISS) with work on the third site (Lau Basin) well established. - Made time-series measurements of seismicity, hydrothermal flow, fluid composition and biological systems at the ISS. - Mounted rapid response expeditions which enabled observation of the recovery of physical and biological systems after singular events. - Established accessible data repositories for considerable cruise information - Developed an effective outreach program to scientists and the public. **Recommendations:** - The program must ensure that it achieves its original objectives of integrating and synthesizing its observations to model the wide-ranging interactions at mid-ocean ridges. - These synthesis objectives must become the highest priority during the remaining years of R2K, preparing for the planned end of the program in 2012. This work should take precedence over, and provide the justification for, any new field studies. - The planned field work scheduled for the Lau basin ISS is a high priority, and additional studies may be justified. However, it is important at Lau to begin fostering integration and synthesis of data to entrain the modeling community as soon as possible - It is unlikely that there is sufficient time and resources in the R2K program to permit development of a full new ISS at the Mid-Atlantic Ridge. The need for any new field studies should be evaluated carefully against the priority for modeling studies for integrating and synthesizing existing data. - The excellent web-based data repository generated by the program needs to be extended to include all the data, particularly fluid chemistry and biological data. R2K should ensure that the office and Steering Committee are appropriately staffed to achieve the integration and synthesis goals in the final part of the program. **Availability:** http://www.ridge2000.org/science/program_review_2008/panel_rec.html

	Directorate for Math and Physical Sciences (MPS)
2008 Annual Report of the Astronomy and Astrophysics Advisory Committee (AAAC) ***March 2008***	**Scope:** The AAAC advises the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and the U.S. Department of Energy (DOE) on selected issues within the fields of astronomy and astrophysics that are of mutual interest and concern to the agencies. Astronomy and astrophysics are understood to encompass observations and theoretical investigations of astronomical objects and phenomena, including the sun and solar-system bodies. Specifically, the AAAC is charged to: Assess and make recommendations regarding the coordination of astronomy and astrophysics programs of the NSF, NASA and DOE. This includes the identification of gaps and duplications among the agencies in areas such as research, analysis programs, missions, observatories, facilities and archives. Assess and make recommendations on the status of NSF, NASA and DOE activities as they relate to the recommendations contained in National Research Council reports, especially the 2001 report "Astronomy and Astrophysics in the New Millennium." **Findings:** The AAAC's findings and recommendations for the agencies from the March 2008 are summarized below and discussed in detail in the report. **Recommendations:** The AAAC's strongest recommendation this year was that the goals of ACI and America COMPETES be realized for the NSF and the DOE Office of Science, and that the NASA science funding be enhanced, in accord with America COMPETES. The AAAC welcomed the continuing interest and support of Congress for the astronomical research program at NASA, NSF and DOE, but hopes that representations from individuals or groups for projects of interest to the petitioners do not lead to directives or earmarks that distort the astronomy community's strategic, consensus-driven priorities. The experience gained by the AAAC in helping to implement the recommendations of the 2000 Decadal Survey is represented in its Task Force reports and its Annual Report. The AAAC encouraged the agencies to discuss the AAAC Task Force reports and the AAAC Annual Report in their interactions with the Survey Committee and its Panels, as the AAAC

	plans to do when it meets with the 2010 Decadal Survey Chair. Given the uncompleted queue from the 2000 Decadal Survey, the AAAC feels that it is essential that *all* projects not under construction be considered again (e.g., GSMT, LSST, Con-X, LISA, SIM, etc.). The AAAC strongly encouraged the agencies and the NRC to build on the success of the BEPAC process, which used, in addition to scientific excellence, independent assessments of technical readiness and lifecycle cost to develop its recommendations and hoped that this approach will be a model for the next Decadal Survey. The AAAC also identified and commented on a number of programs that present particular opportunities and/or raise issues for the vitality of the nation's astronomy and astrophysics enterprise as carried out by NSF, NASA and DOE within the framework of the astronomy and astrophysics 2000 Decadal Survey and similar NRC reports and discussed specific programs and activities that involve interagency coordination. **Availability:** http://www.nsf.gov/mps/ast/aaac/reports/annual/aaac_2008_report.pdf

	Directorate for Math and Physical Sciences (MPS)
The National Science Foundation's Materials Research Science and Engineering Centers Program: Looking Back, Moving Forward	**Scope:** The Materials Research Science and Engineering Centers (MRSEC) Impact Assessment Committee was charged to examine the impact of the MRSEC program from its inception over ten years ago. **Conclusions:** 1) MRSEC center awards continue to be in great demand. The intense competition within the community for them indicates a strong perceived value. These motivations include: • The ability to pursue interdisciplinary, collaborative research; • The resources to provide an interdisciplinary training experience for the future scientific and technical workforce from undergraduate to postdoctoral researchers; • Block funding at levels that enable more rapid response to new ideas, and that support higher-risk projects, than is possible with single-investigator grants; • The leverage and motivation MRSECs provide in producing increased institutional, local, and/or state support for materials research; • The perceived distinction that the presence of a MRSEC gives to the materials research enterprise of an institution, thus attracting more quality students and junior faculty; and • The infrastructure that MRSECs can provide to organize and manage facilities and educational and industrial outreach. 2) The committee examined the performance and impact of MRSEC activities over the past decade in the areas of research, facilities, education and outreach, and industrial collaboration and technology transfer. The MRSEC program has had important impacts of the same high standard of quality as those of other multi-investigator or individual-investigator programs. Although the committee was largely unable to attribute observed impacts uniquely to the MRSEC program, MRSECs generally mobilize efforts that would not have occurred otherwise. 3) The effectiveness of MRSECs has been reduced in recent years by increasing requirements without a commensurate increase in resources. Increasing the mean grant size is necessary to allow the program to fulfill its important mission goals. 4) NSF encourages MRSECs to operate as a national network. Although some efforts have been made in that direction, the committee did not observe strong cooperation among the discrete centers of the program. The MRSEC program is thus missing a clear opportunity to leverage resources and thereby strengthen the materials-research enterprise as a whole.

	Recommendations: To respond to changes in the budgetary landscape and changes in the nature of materials research in the coming decade, NSF should restructure the MRSEC program to allow more efficient use and leveraging of resources. The new program should fully invest in centers of excellence as well as in stand-alone teams of researchers. **Availability:** http://www.nap.edu/catalog.php?record_id=11966

	Office of Cyberinfrastructure (OCI)
NSF International Research Network Connections Program ***January 2008***	**Scope:** The workshop attempted to answer the following question: What infrastructure will be required to support international collaborative science in the year 2010 and beyond? Scientists and researchers from a wide range of disciplines and domains were invited to present. A formal report on the workshop has been submitted to NSF and a link to the report is provided at the end of this document. **Findings:** Some surprising findings from the scientific presentations and international collaborations given at the workshop and International meetings included how dependent International Science is on the network connections provided by the IRNC program and how most of the scientists and researchers had no knowledge of the NSF IRNC program. While this is a testament to the success of the program (enabling international collaboration and research) it is also troubling as the value of the program does not seem to be adequately recognized which may lead to inadequate funding. At the same time, it is abundantly clear that the IRNC program is highly valued and recognized internationally, and has leveraged and obtained enormous support and resources far beyond the NSF contributions. The IRNC program is a critical element of U.S. international science policy and a core component of NSF's support of international Cyberinfrastructure. The IRNC program must not only be continued, but it needs to be significantly expanded and enhanced to support the next generation of scientific collaborations. Without expansion, the U.S. will lose ground and credibility in scientific discovery and international partnerships. **Recommendations:** The recommendations below are aimed at ensuring US leadership and collaboration in the international science community on issues of global importance, and thereby transforming US research and education in the future decades. **Extend Strategic Position and Leverage:** 1. Additional funding must be provided to maintain and extend the current US leadership and strategic positioning in networking to the entire world as well as being able to leverage funding and contributions from other nations. This is particularly true in light of the increasing investments by other countries in links that bypass the U.S. In discussion of the current IRNC projects it was clear that the program has done a remarkable job of leveraging the government investments. Leverage factors have multiplied

	the value of every federal dollar beyond any reasonable expectation. In summary, the IRNC program has invested $24.3M over the last 5 years in international connectivity; foreign investments supporting the IRNC infrastructure is estimated to be $246M to $360M – a 10:1 or 15:1 ratio. Without that leverage, the U.S. would be even further behind in international research networking. **Programmatic Strategies** 2. **Create Programmatic Flexibility:** The IRNC program should provide for "opportunistic" proposals that take advantage of unique moments in time. These include enabling investment in new commercial fiber optic cable projects at the time they are being developed when the costs are lowest and partnering with other international initiatives (e.g., TEIN3, or the new fiber builds taking place in Africa) as they are rolled out. The current 5-yr funding cycle does not maximize flexibility, and this will be even more important in the future to maximize leverage of U.S. investments. 3. **Encourage Partnerships with International Connection Programs:** The IRNC program should encourage the development and coupling of international connection funding programs from other countries such as the EU, Japan, China and so forth. This may also include more coordination with international projects such as GLIF and include funding of people and travel. 4. **Continue Dual Track Strategy:** The IRNC program should continue to simultaneously support "production" research networking and research network R&D. The two components benefit from integration at the individual project and investigator level. It may be worth exploring the availability or feasibility of multiple lambdas or even dark fiber for some of the international connections. Other components to be addressed include best-effort IP networks, IPv6, international multicast and hybrid networks and end-to-end connections programs. The need for peering across multiple international domains at line speed is important. **Programmatic Activities** 5. **Broaden Programmatic Activities:** IRNC cannot just be about network connectivity; it needs to address higher levels in the network stack as well as the larger world of cyberinfrastructure; this includes attitude, people connections, exchanging knowledge and expertise, working together globally and virtually. This may include the need to create more “hubs” for international collaborations (like PRAGMA) where people and technology from various countries can come together. 6. **Orchestrate Interactions among International Collaborators:** The next instantiation of the IRNC program should have a component that focuses on creating a structure that will facilitate regular and frequent interaction between international collaborators, especially across domains. This will increase sharing and reduce duplicative and reinvention of software, tools and applications. The Workshop Organizers believe that greater national and international coordination would be useful in maximizing the value and utility of international cyberinfrastructure and networking investments. This needs to take place across disciplines (e.g.,

	multiple NSF Directorates, agencies (including science agencies outside the U.S.), research methodologies (e.g., networking, data, computation, and visualization) and nations. 7. **Address Needs of End-to-End Support and Training:** As the importance of international collaboration continues to grow, the IRNC program should also address the need for end-to-end support and last mile services. Another aspect includes the need for more training and education, especially as scientists move up power and capability curves to conduct their science. 8. **Leverage Regional Programs:** Geographic realities suggest that international networking programs address domestic issues as well. The work of WHREN with Puerto Rico is one example, and that of TLPW with Hawaii is another. The IRNC program should leverage these opportunities and identify opportunities for domestic co-funding (e.g., EPSCoR) where appropriate. 9. **Interconnect Major Scientific Instruments:** It is clear that a more formal effort should be undertaken to interconnect all the major scientific instruments across the globe. However, this is outside the purview of the IRNC program itself. The IRNC program could play a role in encouraging appropriate domains and disciplines to partner or participate in specific IRNC awards. For example, through a more formal partnership with the Astronomy directorate, as well as with sister programs in the EU, Japan, China and so forth, the Astronomy community might be able to leverage some of the IRNC infrastructure to help connect all the telescopes to high speed networks so they can be shared globally. This includes some early planning for projects like the Square Kilometer Array (SKA) which will have enormous data and transmission requirements. 10. **Address Network and Cyberinfrastructure Security:** Network and cyberinfrastructure security should be more explicitly addressed in the next version of the IRNC program – perhaps through specific out-of-band awards or as subprojects within the program. This includes encouraging policies and processes which support and enable international agreements and help develop an environment of trust to support collaboration science. 11. **Develop Tools and Standards for Collaboration:** Development of more easy-to-use tools for collaboration and support, especially support of international data standards, metadata generation, provenance and storage would be useful. This is especially important as the global network of instruments will increase by a factor of at least a 1,000 over the next 3 years. Data capacity and compute capability will increase by a factor of 500. Development of standards will require activity partnerships with other directorates at NSF and their communities. 12. **Extend Connections to All Countries:** Encourage deeper and wider international collaborations with scientists from every continent; some targeted efforts and funding for third world countries and science similar to the EPSCoR program NSF supports domestically. This should probably include a partnership and joint program with multiple directorates working with OISE and OCI to address international cyberinfrastructure issues and develop new capabilities. Availability: http://www.renci.org/publications/irncworkshop.php

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Building Effective Virtual Organizations ***January 2008***	**Scope:** Virtual organizations (VO) are increasingly central to the science and engineering projects funded by the National Science Foundation. The Building Effective Virtual Organizations Workshop assembled a world-class lineup of speakers to help address the knowledge gap of how to establish distributed teams, how to make them successful, and what technologies exist that can help them function effectively. The goal of the workshop was to share systematic knowledge about the components, characteristics, practices, and transformative impact of effective VOs; identify topics for future research that will inform the ongoing design, development, and analysis of VOs for science and engineering research and education; and create a new cross-disciplinary VO research community to conduct research across a range of important topics. **Findings:** Workshop participants identified a number of research challenges going forward: definitions of VOs, frameworks for comparison, lifecycles, diversity, impacts of research on implementation, technology for knowledge and data sharing, collaboration within and across disciplines, human interaction, scaling, motivation and rewards, governance, and metrics and assessment. Certain development challenges also exist, including the tension between customization and shared infrastructure as well as the deployment, maintenance, and support of infrastructure. **Recommendations:** The report concludes with a set of recommendations for how to move forward: • Encourage cross-disciplinary studies involving both technologists and social scientists working with domain-centered VOs. • Combine knowledge from multiple studies to present a framework that can inform further VO research and practice. • Develop a checklist of necessary VOs features— technological, social, organizational, and so on—to ensure that new VOs start off on the right track. • Design instrumentation, metrics, and evaluation as part of a VO from the beginning rather than adding measurements systems postmortem. • Support human capital development around VOs. • Investigate whether technological and organizational factors that support effective virtualization can be standardized or provided as commoditized infrastructure. • Offer awards for supporting community services at all levels, including the development of new scientific applications, operation of technology infrastructures, and ongoing maintenance

	of these services. • Identify incentives and offer rewards for "metacontributors" to VOs—the people who build or reorganize features to make it easier for others. • Support the development of hardened common tools and protocols for sharing knowledge and data. • Create proposal funding models that support the use and reuse of VO infrastructures. • Encourage universities to support VOs with substantial, complementary investments. • Establish cross-directorate funding opportunities that could more appropriately evaluate and support projects uniting social scientists, computer scientists, and domain scientists. **Availability:** http://www.ci.uchicago.edu/events/VirtOrg2008/

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The Next Generation Research Grid: A Path Forward	**Scope:** This project worked with stakeholder communities to collect ideas for the next generation of the TeraGrid. TeraGrid currently uses high-speed network connections to integrate high-performance computers, data resources and tools, and experimental facilities at eleven resource provider sites around the country. To address changes that are already occurring and are anticipated to take place in high-performance computing (HPC) and computational science over the next 5-7 years, a steering committee was convened with representatives of key stakeholder communities to facilitate a planning process to help guide the future evolution of TeraGrid. The committee was charged to provide a report to stakeholders that identified options for the definition, design, and implementation of the next generation of the NSF TeraGrid program. The committee considered the results of a series of planning workshops, hosted "town hall" meetings, solicited position papers from current TeraGrid users and other national and international stakeholders, examined relevant reports and other documents, incorporated information from the TeraGrid Evaluation Research Study, interacted individually with stakeholders, and deliberated extensively. **Findings:** The TeraGrid has been responsive to increases in the number of resource providers, the evolving technological landscape, and changes in the types of users, usage modes, and user requirements. However, the open, agile, and robust production infrastructure needed for the next generation research grid requires: • a funding model designed to support the program attributes over extended time periods • a strategic plan that includes statements of vision, mission, and values, a list of specific goals, a description of the ways in which those goals will be met, and scheduled reassessment of the plan at set intervals regularly against pre-specified metrics, and • a governance structure and a management plan that includes multiple avenues for stakeholder participation, including a formal advisory structure that reports both to the NSF and to project management. **Recommendations:** To ensure that the Next Generation Research Grid (NGRG) has the stability, direction, leadership, and community support that will be necessary to its success and to its ability to remain agile in the face of technological change, we suggest that the NSF prepare a two-step announcement of opportunity for competitive planning grants leading

	ultimately to the selection of an entity to manage the NGRG. The initial announcement would require proposers to describe how they would conduct a process whose end result would be: • a strategic plan, including a description of a strong and responsive governance structure and management plan (as outlined above) • a description of how standards would be used in the creation of the next generation research grid and the way in which the management structure would effect its use • plans to create an accessible and user-friendly production quality cyberinfrastructure environment • plans to provide mechanisms and procedures to enable research, development, and testing of cyberinfrastructure standards and tools, without impacting production operations of the NGRG • strategies for broadening participation to include new users, disciplines, resource providers, partners, and science gateways • processes to interoperate with Track 1 and Track 2 systems and with data storage, analysis, and visualization systems and pathways to these resources from campus level systems and other high-performance computing centers in an extensible partnership mode7 • an approach to preserve agility in the face of inevitable technological change • plans for the career development of people who will support the infrastructure and computational science • a plan to coordinate and cooperate with other national and international cyberinfrastructure providers and to provide leadership in the development of an international grid infrastructure • an allocation process matched to program attributes • an education and outreach program serving and expanding the community that will create, utilize, support, and extend the cyberinfrastructure to enable research discovery and learning for present and future generations It is vitally important that OCI and the directorates coordinate their strategic plans because in many ways the directorates are the most important customers of the next generation research grid. The NGRG should be strongly driven by the needs of current and future research communities able to make significant strides with the use of modern high-end cyberinfrastructure. Thus, in addition to the product that would result from the announcement of opportunity, mechanisms should be developed for other research programs supported by NSF directorates to coordinate with OCI and to make use of the NGRG as an integral part of their programs and to provide incentives for alignment. **Availability:** http://teragridfuture.org/