

PERFORMANCE INFORMATION

This chapter describes how the Foundation monitors progress toward the strategic outcome goals that underpin the FY 2010 Request.

The following table summarizes the FY 2010 funding requirements for NSF's strategic outcome goals.

This chapter includes information on how NSF evaluates the impact of its investments under the strategic outcome goals of Discovery, Learning, Research Infrastructure, and Stewardship; the agency's performance assessment framework; and examples from STEM education programs of how performance evaluation is used to inform program design and improvement in three directorates.

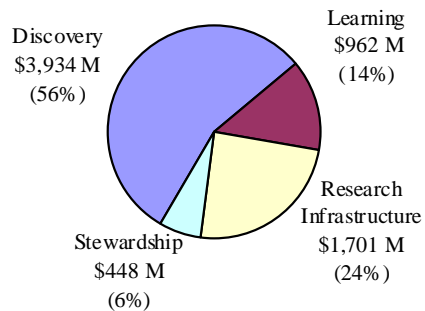
For more information about NSF's performance assessment activities and annual performance reports, see NSF's Budget and Performance Website: www.nsf.gov/about/performance/.

National Science Foundation By Strategic Outcome Goal (Dollars in Millions)

	FY 2008 Actual	FY 2009	FY 2009	FY 2010 Request	Change over	
		Current Plan	ARRA Estimate		FY 2009 Current Plan	Percent
Discovery	\$3,290.24	\$3,509.02	\$1,597.32	\$3,934.06	\$425.04	12.1%
Learning	848.74	896.71	261.78	962.14	65.43	7.3%
Research Infrastructure	1583.76	1673.27	1140.90	1701.14	27.87	1.7%
Stewardship	361.31	411.40	2.00	447.66	36.26	8.8%
Total, NSF	\$6,084.04	\$6,490.40	\$3,002.00	\$7,045.00	\$554.60	8.5%

Totals may not add due to rounding.

NSF's FY 2010 Request by Strategic Goal



NSF'S STRATEGIC FRAMEWORK

NSF's Strategic Plan for FY 2006 – 2011, (www.nsf.gov/pubs/2006/nsf0648/nsf0648.jsp) established four long-term strategic goals as the framework for the agency's activities and performance.

- *Discovery* – Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit, and establishing the nation as a global leader in fundamental and transformational science and engineering.
- *Learning* – Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.
- *Research Infrastructure* – Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure, and experimental tools.
- *Stewardship* -- Support excellence in science and engineering research and education through a capable and responsive organization.

STRATEGIC OUTCOME GOAL 1: 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.

Investments in *Discovery* support cutting-edge research that yield new and important discoveries and promote the development of new knowledge and techniques within and across traditional boundaries. These investments enable NSF to meet its mission of promoting the progress of science while at the same time helping to maintain the Nation's capacity to excel in science and engineering, particularly in academic institutions. The results of NSF-funded research projects provide a rich foundation for broad and useful applications of knowledge and the development of new technologies. Support in this area also promotes the education and training of the next generation of scientists and engineers by providing them with an opportunity to participate in discovery-oriented projects.

To evaluate research and education outcomes under *Discovery*, NSF convenes an external expert group, the Advisory Committee for GPRA Performance Assessment (AC/GPA), which determines whether the Foundation has demonstrated significant achievement under this goal. In FY 2008, the AC/GPA determined that NSF had achieved this goal. At its June 2009 meeting, the AC/GPA will discuss ways to enhance NSF's performance assessment activities and framework. The committee's recommendations will inform the Foundations' framework for performance evaluation in FY 2010.

Resources Required for FY 2010: Successful achievement of this goal is dependent on NSF receiving the resources outlined below.

Support of Discovery Goal by Appropriation

(Dollars in Millions)

	R&RA	EHR	MREFC	AOAM	OIG	Total
Discovery	\$3,755.16	\$178.90	-	-	-	\$3,934.06

Means and Strategies for Success: NSF’s ongoing portfolio of investments and continuing priorities are outlined in this budget submission. In addition, the following long-term investment priorities associated with the strategic goal of *Discovery* have been identified for increased emphasis or additional funding during the period of the Strategic Plan, FY 2006-2011:

- Promote transformational, multidisciplinary research.
- Investigate the human and social dimensions of new knowledge and technology.
- Further U.S. economic competitiveness through basic research that can lead to new, valuable, and marketable technologies.
- Foster research that improves our ability for sustainable living on Earth.
- Advance fundamental research in computational science and engineering, and in fundamental, applied, and interdisciplinary mathematics and statistics.

STRATEGIC OUTCOME GOAL 2: LEARNING

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

Leadership in today’s knowledge economy requires scientists and engineers and a national workforce that is scientifically, technically, and mathematically strong. Investments in *Learning* aim to improve the quality and reach of science, engineering, and mathematics education and enhance student achievement. Each year, NSF supports an estimated 200,000 people – teachers, students, and researchers at every educational level and across all disciplines in science and engineering. In FY 2009, that number is expected to increase.

Embedded in all NSF programs are efforts to build a more inclusive, knowledgeable, and globally-engaged workforce that fully reflects the strength of the Nation’s diverse population. Because science and engineering increasingly address global questions of significant societal importance, today’s research requires globally-engaged investigators working collaboratively across agencies and international organizations to apply the results of research to long-standing global challenges.

To evaluate research and education outcomes under *Learning*, NSF convenes an external expert group, the Advisory Committee for GPRA Performance Assessment (AC/GPA), which determines whether the Foundation has demonstrated significant achievement under this goal. In FY 2008, the AC/GPA determined that NSF had achieved this goal. At its June 2009 meeting, the AC/GPA will discuss ways to enhance NSF’s performance assessment activities and framework. The committee’s recommendations will inform the Foundations’ framework for performance evaluation in FY 2010.

Resources Required for FY 2010: Successful achievement of this goal is dependent on NSF receiving the resources outlined below.

Support of Learning Goal by Appropriation

(Dollars in Millions)

	R&RA	EHR	MREFC	AOAM	OIG	Total
Learning	\$314.00	\$648.14	-	-	-	\$962.14

Means and Strategies for Success: NSF’s ongoing portfolio of investments and continuing priorities are outlined in this budget submission. In addition, the following long-term investment priorities, associated

with NSF's Strategic Outcome Goal of *Learning*, have been identified for increased emphasis or additional funding during 2006-2011.

- Build strong foundations and foster innovation to improve K-12 teaching, learning, and evaluation in science and mathematics.
- Advance the fundamental knowledge base on learning, spanning a broad spectrum from humans to animals and machines.
- Develop methods to effectively bridge critical junctures in STEM education pathways.
- Prepare a diverse, globally-engaged STEM workforce.
- Integrate research with education, and build capacity.
- Engage and inform the public in science and engineering through informal education.

STRATEGIC OUTCOME GOAL 3: RESEARCH INFRASTRUCTURE

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

NSF investments in *Research Infrastructure* 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 support for large multi-user facilities helps create state-of-the-art research platforms vital to new discoveries and the progress of research. NSF support may include construction, upgrades, operations, maintenance, and personnel needed to assist scientists and engineers in the conduct of research at such facilities. NSF consults with other agencies and international partners to avoid duplication and optimize capabilities for U.S. researchers. NSF also supports the work of Science Resources Statistics, which fulfills the mandate of the NSF Act to provide an information resource on the science and engineering enterprise.

To evaluate research and education outcomes under *Research Infrastructure*, NSF convenes an external expert group, the Advisory Committee for GPRA Performance Assessment (AC/GPA), which determines whether the Foundation has demonstrated significant achievement under this goal. In FY 2008, the AC/GPA determined that NSF had achieved this goal. At its June 2009 meeting, the AC/GPA will discuss ways to enhance NSF's performance assessment activities and framework. The committee's recommendations will inform the Foundations' framework for performance evaluation in FY 2010

Resources Required for FY 2010: Successful achievement of this goal is dependent on NSF receiving the resources outlined below.

Support of Research Infrastructure Goal by Appropriation

(Dollars in Millions)

	R&RA	EHR	MREFC	AOAM	OIG	Total
Research Infrastructure	\$1,567.87	\$15.98	\$117.29	-	-	\$1,701.14

Means and Strategies for Success: NSF's ongoing portfolio of investments and continuing priorities are outlined in this budget submission. In addition, the following long-term investment priorities, associated

with the strategic goal of *Research Infrastructure*, have been identified for increased emphasis or additional funding during the period of the Strategic Plan, FY 2006-2011:

- Fill the gaps in our ability to provide enabling research infrastructure.
- Identify and support the next generation of large research facilities.
- Develop a comprehensive, integrated cyberinfrastructure to drive discovery in all fields of science and engineering.
- Strengthen the Nation’s collaborative advantage by developing unique networks and innovative partnerships.

STRATEGIC OUTCOME GOAL 4: STEWARDSHIP

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

The *Stewardship* strategic outcome goal is fundamental to NSF’s leadership in achieving success through its investments in science, engineering, and education research. The Foundation’s *Stewardship* goal priorities include improving the quality of the merit review process, NSF’s service to the science and engineering community, management of large facilities, and the efficiency and effectiveness of administrative and management procedures. Broadening participation from underrepresented groups and diverse institutions is also a high priority.

Within the Foundation, specific program or administrative units assume leadership for monitoring the progress of performance targets under *Stewardship*. In FY 2008, NSF achieved 22 out of the 23 *Stewardship* milestones and measures. Among those achievements were:

- surpassing the Foundation-wide dwell time goal of notifying investigators within six months on whether their proposals will be recommended for funding,
- publishing NSF’s broadening participation portfolio of programs on NSF’s website (www.nsf.gov/od/broadeningparticipation/bp_portfolio.jsp),
- initiating the development of a searchable database of NSF proposal reviewers,
- surpassing the major multi-user facilities operations goal of keeping operating time lost in those facilities to less than ten percent, and
- achieving all post-award monitoring measures and e-Government performance measures.

Resources Required for FY 2010: Successful achievement of this goal is dependent on NSF receiving the resources outlined below.

Support of Stewardship Goal by Appropriation

(Dollars in Millions)

	R&RA	EHR	MREFC	AOAM	NSB	OIG	Total
Stewardship	\$96.21	\$14.74	-	\$318.37	\$4.34	\$14.00	\$447.66

Means and Strategies for Success: NSF’s ongoing portfolio of investments and continuing priorities are outlined in this budget submission. Among the long-term investment priorities identified in the Strategic Plan for *Stewardship* are:

- Strengthen our traditional partnerships and develop new collaborations with other agencies, organizations, and corporations, identifying common goals that can unite and focus partnerships.
- Expand efforts to broaden participation from underrepresented groups and diverse institutions in all NSF activities.
- Improve our processes to recruit and select highly qualified reviewers and panelists.
- Continue as an exemplar in science ethics.
- Enhance the processes for management and oversight of large facilities.

ASSESSING THE PERFORMANCE OF RESEARCH AND EDUCATION PROGRAMS

The Government Performance and Results Act (GPRA) requires that federal agencies develop a strategic plan, establish annual performance goals, and report annually on the progress made toward achieving these goals. GPRA poses a challenge to agencies like NSF that support long-term scientific research. It is often not possible to link outcomes to annual investments because results in basic research and education can be unpredictable. Serendipitous results can be the most interesting and important. Science and engineering research projects can generate discoveries in an unrelated area, and it can take years to recognize the impacts of those discoveries.

To assess the impact of our science and engineering investments, NSF relies for the most part on the qualitative judgment of experts. The value of external expert review was affirmed in two studies by the Committee on Science, Engineering, and Public Policy (COSEPUP) of the National Research Council. In a 2001 report, the committee 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.”¹

NSF’s external evaluation panels consist of the Foundation-wide Advisory Committee for GPRA Performance Assessment (AC/GPA), program-specific Committees of Visitors (COVs), and other external or third-party evaluations. The AC/GPA meets annually to review the previous year’s research and education outcomes. Committees of Visitors are convened once every three years for each of NSF’s programs. See pages 7-8 for more information about the AC/GPA and COV processes.

In FY 2010, the following COVs will be convened to review program management and outcomes:

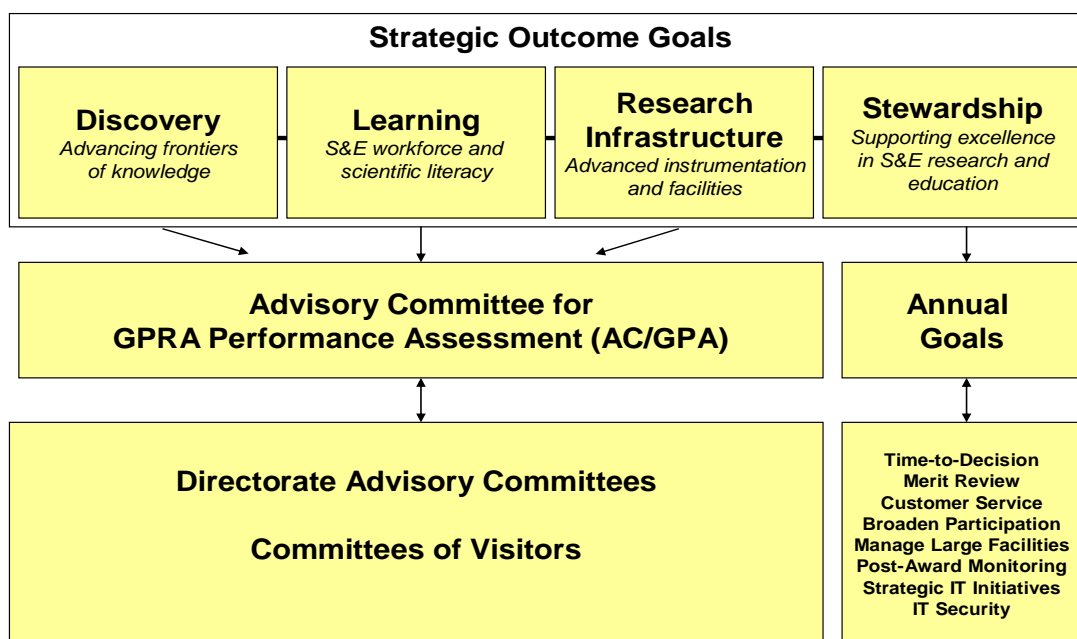
<i>Directorate/Office</i>	<i>Program</i>
Biological Sciences	Biological Infrastructure
Education & Human Resources	Scholarships (S-Stem in FY 2007) Scholarship for Services Alliances for Graduate Education & the Professoriate Centers for Research Excellence in Science & Technology Historically Black Colleges & Universities-Undergrad Prog. Louis Stokes Alliances for Minority Participation Tribal Colleges & Universities Program CAREER Program
Engineering	Engineering Education & Centers Industrial Innovation & Partnerships

¹ *Implementing the Government Performance and Results Act for Research: A Status Report* is available at www.nap.edu/catalog.php?record_id=10106.

	Emerging Frontiers in Research & Innovation
Geosciences	Atmospheric Sciences Earth Sciences Geosciences Education and Diversity programs
Mathematical & Physical Sciences	Chemistry Mathematical Sciences
Social, Behavioral & Economic Sciences	Social and Economic Sciences
Office of Integrative Activities	Major Research Instrumentation

A schedule of COV evaluations planned through FY 2011, as well as a list of external evaluations completed during FY 2008, is available in NSF's FY 2008 Annual Performance Report (Appendix D): www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf0922

NSF'S PERFORMANCE ASSESSMENT FRAMEWORK



Advisory Committee for GPA Performance Assessment (AC/GPA)

The AC/GPA, composed of about 20 scientists, engineers, and educators, conducts an annual agency-wide review of NSF's investments in research and education under its strategic outcome goals. The Committee reviews a large number of program outcomes, or "highlights," written by program officers to demonstrate the accomplishments of principal investigators. The Committee's charge is to determine whether the Foundation demonstrated significant achievement under the goals and submit a report to the NSF Director. The committee's conclusions and recommendations are included in NSF's Annual Performance Report. At its meeting in June 2009, the AC/GPA will discuss ways to enhance NSF's performance evaluation framework.

Directorate and Special Topic Advisory Committees (ACs)

Each directorate and office has an AC that normally meets twice a year to provide guidance on priorities, address program effectiveness, and review COV reports and management's response to COV recommendations. Advisory Committees are chartered and subject to Federal Advisory Committee Act (FACA) rules. COVs are subcommittees of NSF directorate advisory committees. NSF also has four advisory committees focused on the topics of: Equal Opportunities in Science and Engineering, Environmental Research and Education, Astronomy and Astrophysics, and Business and Operations.

Committees of Visitors (COVs)

Each division or crosscutting program is assessed by a Committee of Visitors once every three years. A COV typically consists of up to 20 external experts, selected to ensure independence, programmatic coverage, and geographic balance, and they represent academia, industry, government, and the public sector. They meet for two or three days to review and assess program priorities, program management, and award accomplishments or outcomes. Approximately one-third of NSF's divisions are assessed each year.

COVs are asked to comment on program activities as they relate to NSF's strategic outcome goals, justify their findings, and provide supporting examples or statements. Each COV prepares a report and the division or program that is being reviewed must prepare a response. These reports and responses are submitted to the parent advisory committee and to the Director of NSF. COV recommendations must be addressed by the division director, and appropriate actions must be taken to comply. All reports and responses are public and posted on NSF's website at: www.nsf.gov/od/oia/activities/cov/covs.jsp.

Verification and Validation of Performance Goals

The Government Accountability Office (GAO) has provided guidance to federal agencies on how to provide confidence that the policies and procedures underlying performance reporting are complete, accurate, and consistent.² Following that guidance, NSF engaged IBM Global Business Services (IBM) to conduct an independent validation and verification (V&V) review of its annual performance information, data, and processes. IBM assessed the validity of the data and verified the reliability of the methods used to collect, process, maintain, and report data, and reviewed NSF's information systems based on GAO standards for application controls. IBM's FY 2008 V&V report to NSF concluded 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.³

² GAO Guide to Assessing Agency Annual Performance Plans, GAO/GGD-10.1.20.

³ IBM Global Business Services, *NSF Fiscal Year 2008 - Performance Measurement Verification and Validation Report*, October 22, 2008.

**PERFORMANCE EVALUATION AND PROGRAM IMPROVEMENT:
EXAMPLES FROM NSF’S LEARNING PORTFOLIO**

NSF’s *Learning* portfolio consists of the science, technology, engineering, and mathematics (STEM) education programs within the Directorate for Education and Human Resources (EHR), as well as programs such as those in the Engineering and Geosciences directorates described later in this chapter. The portfolio includes a wide range of programs for K-12 students and teachers, undergraduate students, graduate students, postdoctoral fellows, and informal science education and lifelong learning – nearly 60 programs in total. NSF is committed to improving the quality of STEM education as part of our vision of “advancing discovery, innovation and education beyond the frontiers of current knowledge and empower future generations in science and engineering.”

NSF recognizes that evaluations of the *Learning* portfolio offer timely opportunities for program improvement and redesign. The Foundation is increasing its efforts to improve the quality of program evaluations, implement more evaluations, and build Foundation-wide capacity in this area. Evaluations of programs in the *Learning* portfolio, both by external organizations and groups and by NSF program staff, are also an integral part of the Foundation’s current effort to develop performance metrics for STEM education programs. It must be recognized, however, that there is a range of evaluation goals, questions, metrics, and designs in use, and that different types of evaluation programs are employed for activities at different stages of their progress.

An evaluation framework for STEM education programs currently under discussion within NSF is:

EVALUATION FRAMEWORK FOR STEM EDUCATION (LEARNING) PROGRAMS

<i>Formulation of evaluation goals and metrics</i>	<i>Data gathering</i>	<i>Design and implementation of studies to examine outcomes, impact, program contribution</i>	<i>Design and implementation of long-term follow up for impact</i>
Creating logic models; Analyzing the portfolio; Framing questions for accountability and program improvement; Developing metrics	Establishing monitoring systems; Conducting surveys; Compiling project-level evaluations; Describing strategies within the portfolio; Review by experts	Studies comparing outcomes before and after program; Studies comparing well-defined strategies within program; Analysis of R&D contribution via expert review	Longitudinal studies; Network analysis; Citation review; Syntheses

The following examples of program evaluations recently conducted or ongoing in EHR, the Engineering Directorate, and the Geosciences Directorate illustrate the use of performance evaluation to improve program design and implementation.

Directorate for Education and Human Resources (EHR)

The Directorate for Education and Human Resources (EHR) supports about 30 programs that focus on the improvement of STEM education within the United States from the K-12 level through graduate student and professional levels, and in both formal school settings as well as informal learning environments. All of these programs undergo periodic external evaluation over and above the standard NSF evaluation process through Committees of Visitors. In addition, all projects (awards) supported by EHR must contain an evaluation plan and progress is monitored by program directors throughout the course of the award. Evaluations of three key EHR programs are described below: the Advanced Technological Education (ATE) program, the Graduate Research Fellowship (GRF) program, and the Math and Science Partnership (MSP) program.

The **Advanced Technological Education (ATE) Program** focuses on the education of technicians for the high-technology fields that drive our Nation's economy. With an emphasis on two-year colleges, the program involves partnerships between academic institutions and employers to promote improvement in the education of science and engineering technicians at the secondary school and undergraduate levels.

Each year since 2000, the Evaluation Center at Western Michigan University has surveyed all centers and projects that have been active for at least one year (about 170). A survey tracks evaluation of projects' development of materials, professional development of teachers, program improvement, and student recruitment and retention. More than 80,000 students took at least one course in an ATE-funded project in 2007, and about equal numbers of two-year college faculty and high school teachers and workers from industry were part of the 49,000 who took part in ATE-funded professional development. More than 2,600 curricula and other educational materials were developed by 57 ATE programs during 2007, and ATE initiatives developed about 1,500 new articulation agreements between high schools and two-year colleges and between two-year and four-year colleges. Center surveys and other information about the ATE Program are available at: www.wmich.edu/evalctr/ate/.

The **Graduate Research Fellowship (GRF) Program** is NSF's flagship program for support of graduate students. It provides three years of support for graduate study leading to research-based master's or doctoral degrees, and is intended for students who are in the early stages of their graduate study in disciplines supported by the Foundation. The program provides a stipend and a cost-of-education allowance. A student survey and program evaluation of the 1979-1988 cohort conducted by WestEd found that GRF students complete the Ph.D. at higher rates than any other comparable population, have shorter time to degree completion, reach faculty positions with greater frequency, and enjoy higher rates of career productivity than most peer groups. The WestEd report was published in 2002 and is available at www.nsf.gov/pubs/2002/nsf02080/start.htm. The National Opinion Research Center (NORC) has just begun another three-year program evaluation, which will focus on the 1989-1998 cohort, and will include a follow-up study of the fellows' graduate experiences and career outcomes.

Equally if not more important for program evaluation are the assessments and recommendations of Committees of Visitors. As a result of recommendations made by two COVs in 2003 and 2007, the GRF program staff introduced more precise and efficient program management practices. Those practices include: converting to an entirely electronic application and panel review process; developing revised eligibility criteria to allow more advanced graduate students to apply; and increasing the flexibility of how the graduate students may use their fellowships. The 2007 COV recommended that the Program staff expand their outreach to minority-serving institutions in order to increase the numbers of applicants from underrepresented groups who apply for and win fellowships. As a result of the outreach activities,

which included more visits to those institutions, partnerships with other federal agencies, and an enhanced website, a record number of applications was submitted in FY 2009.

The **Math and Science Partnership (MSP) Program** is a major research and development effort now active in 35 states, Puerto Rico, and the Virgin Islands. It supports innovative partnerships to improve K-12 student achievement in mathematics and science. MSP projects are expected to raise the achievement levels of all students and significantly reduce achievement gaps in the mathematics and science performance of diverse student populations. The MSP program coordinates with the Mathematics and Science Partnerships program of the U.S. Department of Education in the expectation that effective innovations in mathematics and science education will be disseminated into wider practice. The two programs are significant components of the America COMPETES Act of 2007 (Public Law 110-69).

An external evaluation of the MSP Program is underway by the COSMOS Corporation, in collaboration with Brown University, George Mason University, the McKenzie Group, and Vanderbilt University. The approach developed for the evaluation of the MSP Program was a series of over 20 studies, and program evaluators have begun to publish the design and early results of these studies in peer-reviewed journals. Most recently, the entire Fall 2008 issue - Volume 83, Issue 4 - of the *Peabody Journal of Education* was devoted to the MSP Program evaluation. Project-level evaluations have been in place since the inception of the MSP program, and MSP has provided technical assistance in evaluation to the partnership projects through senior evaluators at the University of Wisconsin-Madison and Utah State University. A product of the interaction between the technical assistance teams, with significant impact on projects by guiding them to effective project-level evaluation, is *Evidence: An Essential Tool – Planning for and Gathering Evidence using the Design-Implementation-Outcomes (DIO) Cycle of Evidence*, which is available at (www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf0531)

MSPNet (www.mspnet.org) supports real-time sharing of strategies and information within the MSP community. Through a common data collection system, the program collects a range of data regarding partnership profiles; types of services offered; engagement by faculty, businesses, and K-12 teachers; and impacts on the teaching force, as well as on student learning. The system allows the program to track longitudinally many elements of the MSP Program, including student achievement in mathematics and science.

In summary, EHR is providing leadership and advancing methodology in comprehensive project-level and program evaluation of STEM education investments. The directorate's programs span a research and development spectrum, and the evaluation efforts are designed to answer questions important for continual program improvement and change, as well as to assess program impact and effectiveness. EHR STEM education program evaluations are typically multifaceted and employ multiple methods. They include evaluation planning (e.g., formulation of goal-related questions and performance measures), data-gathering for portfolio analysis and description, studies of impact and outcomes for program justification, and longitudinal studies for follow-up and impact.

Directorate for Engineering (ENG)

The Division of Engineering Education and Centers (EEC) encourages the integration of engineering research and education to accelerate technological and educational innovation, and improve the quality and diversity of engineering graduates entering the technical workforce. The EEC portfolio includes research to advance our understanding of how students learn engineering, and research on how to improve the attraction and retention of engineering students at all levels of education.

The EEC Division recently funded an external evaluation of two of its programs in engineering education: How People Learn Engineering (HPLE) and Department Level Reform (DLR). HPLE is part of the Innovations in Engineering Education and Curriculum and Infrastructure (IEECI) program. DLR focuses on innovations in curriculum at the department level that involve significant changes in teaching methods, with less emphasis on lectures and more emphasis on teaming and hands-on experiences; better use of technology; and increased emphasis on teaching communication skills to students. The Science and Technology Policy Institute (STPI) conducted the evaluations.

In its review of 37 HPLE research grants, STPI concluded that the typical grantee explores a well-defined research agenda, specifies the concepts to be studied and how they will be measured, pays close attention to data collection and analysis and the potential for its application, produces curricula or other materials as a result of the research activity, and communicates findings broadly. The study recommended that longitudinal outcome assessments be conducted to track the extent to which HPLE-based ideas impact the global engineering education community.

In its review of 20 DLR grants, STPI found that each DLR team accomplished significant curriculum reforms consistent with the National Academy of Engineering (NAE) recommendation that engineering concepts and designs be introduced early in students' undergraduate education in an effort to motivate them to obtain graduate degrees. The reforms also mapped to the Accreditation Board for Engineering and Technology (ABET) criteria that focus on what engineering students should learn, including techniques, skills, and engineering tools that are used by practicing engineers. The study recommended several options for short term and longer term assessments.

The Division of Engineering Education and Centers also supports the Engineering Research Center program, which encourages the integration of engineering research and education. Since 2000, EEC has supported several external evaluations of the ERC program. One of those evaluations, *Designing the Next Generation of NSF Engineering Research Centers: Insights from Worldwide Practice*, conducted by STPI in 2007, helped identify best practices in several countries that NSF will take into account in designing the next generation of ERCs – the so-called “Gen-4” ERCs. Some of the study's recommendations were: develop more flexible Intellectual Property Rights policies, be creative in encouraging commercialization, and support true collaborative research through partnerships and networks. Another study was conducted in 2007 on strategic planning in ERCs, and several studies were conducted on innovations generated by research at ERCs, the impact on industry of interaction with ERCs, and the impact of ERCs on institutional and cultural change in participating institutions.

More information about recent external evaluations of programs within the Division of Engineering Education and Centers is available at: www.erc-assoc.org/topics/6-nsf-policies.html. (See “Summary of ERC Study Findings 2001-2008”)

Directorate for Geological Sciences (GEO)

Two overarching goals for the STEM education programs within the Directorate for Geosciences are:

- To develop a skilled and diverse geoscience workforce for the future that is prepared to work in an increasingly interdisciplinary field, and
- To advance public knowledge and understanding of geoscience content, because of its societal relevance.

GEO's education, outreach, and diversity investments are tightly coupled to its research programs. Emphasis is placed on programs for undergraduates, K-12 teachers, and postdoctoral programs, and programs that engage scientists in education and outreach. Several programs emphasize development and dissemination of best practices, in order to serve a larger audience of learners.

Three GEO programs are described below: GEO-Teach, Opportunities for Enhancing Diversity in the Geosciences (OEDG), and Centers for Ocean Science Education Excellence (COSEE).

GEO-Teach aims to improve the quality of secondary school geoscience instruction at a national scale. The emphasis is on developing effective and sustainable models for scaling up high quality teacher professional development and training activities that increase content knowledge, improve pedagogy, and engage the broader scientific community.

To date there has been one GEO-Teach competition, held at the end of FY 2006, in which two three-year cooperative agreements were awarded:

- The Earth System Science Education Alliance (ESSEA) Project. The principal investigators are at the Institute for Global Environmental Strategies. The purpose of the project is to create a national network of 43 partner and affiliate institutions providing online and face-to-face pre- and in-service teacher preparation resources.
- Transforming Earth Systems Science Education (TESSE) Project. This is a partnership of investigators at the University of New Hampshire, Pennsylvania State University, Dillard University, and Elizabeth City State University. The purpose is to provide pre-service teacher training and in-service professional development in Earth Systems Science.

The evaluation design and methods used, as well as performance metrics, are embedded in the project descriptions. Some preliminary findings from the evaluations indicate that significant progress has been made in establishment of online courses, that participants are actively engaged (attending project conferences, giving presentations, and developing modules to share with their networks), and that formative feedback is being used to increase effectiveness and improve partnership collaboration.

Opportunities for Enhancing Diversity in the Geosciences (OEDG) is aimed at increasing the number of members of underrepresented groups who are involved in formal pre-college geoscience education programs, pursue post-secondary degrees in the geosciences, enter geoscience careers, and participate in informal geoscience education programs. The emphasis is on developing and disseminating best practices for broadening participation in the geosciences, building capacity at minority-serving institutions, and leveraging existing networks and resources. About 95 projects have been awarded to date through two "track" options.

An OEDG program-wide evaluation is being conducted through a five-year contract that was re-awarded in 2008 to the American Institutes for Research (AIR). Track One projects have evaluation support through this contract, while Track Two projects are required to have robust evaluations conducted by an external evaluator. GEO program directors are currently analyzing preliminary results from the evaluations.

Centers for Ocean Science Education Excellence (COSEE) has the goal of improving the broader impacts capabilities of ocean scientists by connecting them to formal and informal educators. Each of the 11 centers promotes activities reflecting their strengths and interests. There is also a COSEE Network Central Coordinating Office and a National Advisory Committee. COSEE supports a broad range of activities (including public lectures, workshops, publications, citizen science activities, and improving displays and materials at public science centers) that foster the engagement of ocean scientists in improving the public understanding of ocean science topics. The major scientific emphases include climate change, ocean chemistry/acidification, coastal ecosystems/environmental issues, and ocean observing education.

Each center has its own evaluation effort, and there is also a network-level evaluation. NSF conducts site visits of the centers and has regular communication with PIs. NSF is currently restructuring the COSEE evaluation effort, aiming to put stronger focus on the impact of activities at the Centers and at the network level, in particular highlighting the impact of the centers' activities on the ocean sciences research community and the public.