GPRA Performance Report FY 1999

National Science Foundation

The NSF Vision

The National Science Foundation is a catalyst for progress through investment in science, mathematics and engineering. Guided by its longstanding commitment to the highest standards of excellence in the support of discovery and learning, NSF pledges to provide the stewardship necessary to sustain and strengthen the Nation's science, mathematics and engineering capabilities and to promote the use of those capabilities in service to society.

NSF is confident in the power of its connections and partnerships to deliver the greatest return on this investment. It will exercise leadership in strengthening linkages among the many individuals, institutions, and organizations that are committed to progress in research and education. It will also dedicate itself to fostering the natural connections between processes of learning and discovery.

At the core of this vision is a dynamic and diverse community of researchers, educators, and institutions who work in partnership with NSF. This community shares with NSF a commitment to discovery and learning, to enhancing the Nation's capacity for excellence in research and education, and to the use of science, mathematics, and engineering for the betterment of humanity.

—From *NSF in a Changing World*

National Science Foundation
Celebrating 50 Years

Director's Statement

It is with great pleasure that I forward NSF's first annual performance report, as required by the Government Performance and Results Act of 1993 (GPRA).

The last fifty years have been a remarkable journey for NSF and for science and engineering in the United States. Our investments — in creative people, in innovative ideas, and in cutting-edge research and education tools — have led to science and engineering achievements that have literally transformed society. NSF-supported activities have played a key role in advancing the microelectronics industry, in leading to a better understanding of the structure and properties of DNA, in developing information-communications technologies, such as the Internet, and in revolutionizing our knowledge of the cosmos and humanity's place in it. NSF-supported researchers have been awarded over one hundred Nobel Prizes in physics, chemistry, physiology, economics, and other fields. These are just a few of the many excellent examples of NSF-supported research and education activities that have had a profound effect on society. In commemoration of our 50th anniversary, we are compiling examples of societal achievements that were made possible by NSF support. This compilation, which will be published and placed on our website later this year, together with this and future GPRA performance reports, will bring into sharper focus the value of NSF investments in science and engineering research and education to society.

This first full year of GPRA implementation has been a learning process for NSF and other federal agencies whose missions involve fundamental research and education activities. The substance and timing of the outcomes of these activities are unpredictable and not easily quantified. In addition, there is the critical issue of timing. Attribution of the societal impacts of NSF awards is often difficult to report on an annual basis because such impacts often occur decades after the initial investments were made. In order to provide an accurate and reliable depiction of the effectiveness of NSF's activities, we developed and obtained approval from the Office of Management and Budget for an alternative GPRA format that takes into account the special challenges inherent in assessing research and education results.

This alternative format, which uses the judgment of independent expert review panels, enables the assessment of the Foundation's performance in three key areas:

- *the outcomes of NSF investments;*
- *the effectiveness of NSF's investment process; and*
- *the value of management activities.*

Outcome goals focus on the long-term results of NSF's grants for research and education in science and engineering. Investment process goals focus on the means and strategies NSF uses to achieve its outcome goals. And, management goals address the efficiency and effectiveness of our administrative activities in support of NSF's mission. Once these assessment goals were determined, NSF put in place new processes and procedures, data collection systems, and committees to measure our performance.

This FY 1999 GPRA performance report affirms NSF's tradition of accomplishment. I am proud to report that NSF was successful in meeting all of our outcome *goals, and we met 12 of the 18 investment process and management goals. Altogether, we were successful in meeting 78% of our goals. The goals that were not met include the length of time NSF takes to process proposals and the timing of program announcements. We will renew our efforts to meet these goals in FY 2000.*

In the new century, NSF remains committed to ensuring the health and vitality of the U.S. science and engineering enterprise. We face daunting challenges and rich opportunities: responding to emerging developments at the frontiers of science and engineering, broadening participation by all members and regions of our nation, strengthening the connections between scientific discovery and technological innovation, modernizing the nation's research and education infrastructure, and positioning the United States to benefit from global investments in science, engineering and technology. I have little doubt that the strategic and performance planning process implemented through GPRA will help NSF meet future challenges and make the most of our opportunities, leading to 21st century science and engineering achievements that will further transform society.

Rita R. Colwell
Director
National Science Foundation

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EXECUTIVE SUMMARY

As the world marks the closing of the 20th century and the beginning of a new millennium, the National Science Foundation is marking its 50th year as the only federal agency dedicated to the support of non-medical fundamental research and education across all science and engineering disciplines and for all levels of education.

Since 1950, NSF has endeavored to maintain U.S. leadership in scientific discovery and the development of new technologies. In contrast to other federal agencies that have mission-oriented research objectives such as energy, biomedicine or space, NSF has the unique federal responsibility of supporting and strengthening the underpinnings for all research disciplines, providing leadership across the frontier of scientific and engineering knowledge. NSF also provides national leadership in improving science, mathematics, engineering and technology (SMET) education and in broadening participation in the SMET enterprise through the development of a diverse, globally oriented workforce.

NSF's Mission:

To promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense...

NSF Creation and Mission

The National Science Foundation (NSF) is an independent agency of the U.S. Government, established by the National Science Foundation Act of 1950, as amended, and related legislation, 42 U.S.C. 1861 et seq., and was given additional authority by the Science and Engineering Equal Opportunities Act (42 U.S.C. 1885), and Title I of the Education for Economic Security Act (20 U.S.C. 3911 to 3922).

The Foundation consists of the National Science Board of 24 part-time members and a Director (who also serves as ex officio National Science Board member), each appointed by the President with the advice and consent of the U.S. Senate. Other senior officials include a Deputy Director who is appointed by the President with the advice and consent of the U.S. Senate, and eight Assistant Directors.

The Act established the NSF's mission:

> *To promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense...*

The Act authorized and directed NSF to initiate and support:

- basic scientific research and research fundamental to the engineering process;
- programs to strengthen scientific and engineering research potential;
- science and engineering education programs at all levels and in all the various fields of science and engineering;
- programs that provide a source of information for policy formulation;
- and other activities to promote these ends.

Over the years, NSF's statutory authority has been modified in a number of significant ways. In 1968, authority to support applied research was added to the Organic Act. In 1980, The Science and Engineering Equal Opportunities Act gave NSF standing authority to support activities to improve the participation of women and minorities in science and engineering. Another major change occurred in 1986, when engineering was accorded equal status with science in the Organic Act.

General Goals and Objectives

NSF carries out its mission primarily by making merit-based grants and cooperative agreements to individual researchers and groups, in partnership with colleges, universities, and other institutions – public, private, state, local, and federal – throughout the U.S. NSF awards provide resources to enable and enhance the nation's capacity for sustained growth and prosperity. NSF invests in individuals and organizations that conduct the work that ultimately leads to the outcomes of the investment process that NSF manages.

NSF's Performance Goals

NSF's FY 1999 Annual Performance Plan includes three sets of mutually supportive goals:

- **Outcome Goals** focus on the long-term results of NSF's grants for research and education in science and engineering.

- **Investment Process Goals** focus on the means and strategies NSF uses to achieve its outcome goals and sets performance targets for the investment processes by which NSF shapes its portfolio of awards.

- **Management Goals** address the efficiency and effectiveness of administrative activities in support of the NSF mission.

The Outcome goals reflect the long-term desired results of NSF awards. Achieving the desired outcome goals depends in part on the quality of the investment process, which is related to the efficiency and effectiveness of the agency's administration and management. The investment process goals and management goals are necessary to ensure that the long-term outcome goals will be achieved.

Outcomes provide the evidence of NSF's success as an investment agent.

FY 1999 was the first full year of implementation of the Government Performance and Results Act of 1993 (GPRA) at NSF. Implementing GPRA has been a challenge for NSF and other agencies whose missions involve research activities. Both the substance and timing of outcomes from research and education activities are unpredictable. This creates difficulty in linking research outcomes to annual investments and the agency's annual budget. Also, the most important results of research – the long-term outcomes – do not easily lend themselves to quantitative reporting. Therefore, NSF developed and obtained OMB approval for use of the "alternative format", which is a qualitative scale for the assessment of outcomes. In using the alternative format, NSF depends on external expert review panels to assess the quality of research results and to report progress toward the outcome goals.

NSF's key strategy for success is the use of merit review to make awards for activities that will influence research and education in mathematics, science and engineering, both directly and indirectly.

NSF's Focus on Outcomes

The outcomes of NSF investments are the long-term results stemming from the grants and cooperative agreements we make. Outcomes provide the evidence of NSF's success as an investment agent. These broad outcomes address the Foundation's programmatic investments that relate to the agency's mission, and are intended to cover the full range of the activities supported by NSF awards.

- Discoveries at and across the frontier of science and engineering;
- Connections between discoveries and their use in service to society;
- A diverse, globally-oriented workforce of scientists and engineers;
- Improved achievement in mathematics and science skills needed by all Americans; and
- Timely and relevant information on the national and international science and engineering enterprise.

In FY 1999, NSF identified goals relevant to achieving the long-term desired strategic outcomes. These are described in further detail in the section on Performance Results of this report.

Means and Strategies - NSF's Focus on Investment Process

The investment process is a competitive process based on merit review by external peers, using criteria established by the National Science Board, which is responsible for establishing the policies of the National Science Foundation. The scientists and engineers comprising NSF's program staff take NSF priorities and the advice of the external reviewers into account in developing their portfolio of awards. Critical to the success of the investment process are the means and strategies for high quality proposal and award processes that support achievement of the outcome goals and meet customer expectations:

- Provide staff resources needed to manage proposal and award processes.
- Provide electronic information systems that support the processes.
- Provide administrative guidance/requirements that reflect the imperatives of high quality processes.
- Provide needed oversight of management to ensure guidance/requirements are met.
- Provide needed operating expenses to ensure credible processes.
- Work with the science and engineering community to provide high quality external review of NSF proposals.

In FY 1999, NSF identified relevant investment process goals. These are described further in the section on Performance Results.

Critical Factors - NSF's Focus on Management

Excellence in managing the agency's processes is an NSF goal on a par with our mission-oriented outcome goals. In the GPRA strategic plan, NSF articulated four critical factors in managing for excellence that provide the framework for annual performance goals. These include:

- Operating a viable, credible, efficient merit review system;
- Exemplary use of and broad access to new and emerging technologies;
- A diverse, capable, motivated staff that operates with integrity; and
- Implementation of mandated performance assessment and management reforms in line with agency needs.

In FY 1999, NSF identified relevant management process goals. These are described further in the section on Performance Results.

SUMMARY OF PERFORMANCE GOALS AND RESULTS

1999 Results for NSF's Outcome Goals

Each of NSF's outcome goals was achieved in FY 1999. Reports from external evaluators consistently judged NSF's programs to result in high quality scientific outputs and outcomes, and to be largely successful in achieving NSF's performance goals. Exceptions were noted in some areas as needing improvement including need to improve balance of portfolio by taking more risk in a few programs and need to show increases in participation of underrepresented groups in science and engineering in some programs.

1999 Results for NSF's Investment Process Goals

Nine of NSF's thirteen investment process goals were achieved in FY 1999, and four goals were not achieved. Areas identified as needing improvement for goals that were achieved include use of the new merit review criteria in some programs. Areas needing improvement where goals were not achieved include making new program announcements and solicitations available at least three months prior to the deadline or target date; decreasing the time to decision; and maintaining openness in the system to increase the percentage of awards to new investigators.

FY 1999 Result Overall: NSF was successful in achieving 78% of its goals.

1999 Results for NSF's Management Goals

Three of NSF's five investment process goals were achieved in FY 1999, and two goals were not achieved. Areas identified as needing improvement where goals were not achieved include orientation and training of NSF staff using FastLane- NSF's electronic system for proposal submission, proposal review, and project reporting; and increasing the use of the new electronic Project Reporting System for project reporting by awardees.

FY 1999 Result Overall: NSF was successful in achieving 78% of its goals.

Table of Performance Goals and Results

The following table lists each goal and the NSF results for FY 1999. Details related to the results, and information related to verification and validation are found in the report following the table. Goals 1 and 2 pertain primarily to the effectiveness of NSF-supported research activities. Goals 3 and 4 pertain primarily to effectiveness of NSF-supported education activities. The remaining goals pertain to both research and education activities.

FY 1999 Annual Performance Goals and Results for OUTCOMES[1]

Strategic Outcomes	FY 1999 Annual Performance Goals	
Discoveries at and across the frontier of science and engineering	**Goal 1.a**	NSF is ***successful when*** NSF awards lead to important discoveries; new knowledge and techniques, both expected and unexpected, within and across traditional disciplinary boundaries; and high-potential links across these boundaries. **FY 1999 Result:** ***Successful.*** In FY 1999, a total of 43 reports by external experts rated NSF for this goal. All 43 reports rated NSF sucessful in achieving this goal.
	Goal 1.b	Relevant to **FY 1999 Government-wide goal:** An independent assessment will judge NSF research programs to have the highest scientific quality and an appropriate balance of projects characterized as high-risk, multidisciplinary, or innovative. **FY 1999 Result:** ***This goal was achieved.*** In FY 1999, all external reports indicated that NSF programs have high scientific quality. Of 30 reports by external experts that gave an opinion on balance of projects in the programs under review, 24 reports indicated that the balance was appropriate.
Connections between discoveries and their use in service to society	**Goal 2**	NSF is ***successful when*** the results of NSF awards are rapidly and readily available and feed, as appropriate, into education, policy development, or use by other federal agencies or the private sector. **FY 1999 Result:** ***Successful.*** In FY 1999, a total of 43 reports by external experts rated NSF for this goal. Of these, 42 reports rated NSF successful in achieving this goal.

[1] Goals 1-4, and Goal 7, are stated in the alternative format provided for in GPRA legislation. A more complete discussion of results is provided in the section on Performance Results.

A diverse, globally-oriented workforce of scientists and engineers	**Goal 3**	NSF is ***successful when*** participants in NSF activites experience world-class professional practices in research and education, using modern technologies and incorportating international points of reference; when academia, government, business, and industry recognize their quality; and when the science and engineering workforce shows increased participation of underrepresented groups. **FY 1999 Result:** ***Successful.*** In FY 1999, a total of 44 reports by external experts rated this goal, with 38 reports rating NSF successful in achieving all or most areas of the goal.
Improved achievement in mathematics and science skills needed by all Americans	**Goal 4.a**	NSF is ***successful when*** NSF awards lead to the development, adoption, adaptation, and implementation of effective models, products, and practices that address the needs of all students; well-trained teachers who implement standards-based approaches in their classrooms; and improved student performance in participating schools and districts. **FY 1999 Result:** ***Successful, in most areas of this goal.*** In FY 1999, 22 reports by external experts rated NSF for this goal. Of these, 18 reports rated NSF successful in achieving this goal in all or most areas of the goal.
	Goal 4.b	Over 80 percent of schools participating in a systemic initiative program will (1) implement a standards-based curriculum in science and mathematics; (2) further professional development of the instructional workforce; and (3) improve student achievement on a selected battery of tests, after three years of NSF support. **FY 1999 Result**: In 1999, 40 NSF sponsored projects implemented mathematics and science standards-based curricula in over 81 percent of participating schools, and provided professional development for more than 156,000 teachers. All participating educational systems demonstrated some level of improvement in student achievement in mathematics and science on a battery of system-selected assessment instruments.
	Goal 4.c	Through systemic initiatives and related teacher enhancement programs, NSF will provide intensive professional development experiences for at least 65,000 precollege teachers. **FY 1999 Result**: In FY 1999, systemic initiatives and related teacher enhancement programs provided intensive professional development to a total of 82,400 teachers, exceeding the goal of 65,000.

FY 1999 Annual Performance Goals and Results for OUTCOMES[1] *(continued)*

Strategic Outcome	FY 1999 Annual Perfomance Goal	
Timely and relevant information on the national and international science and engineering enterprise.	**Goal 5.a**	Decrease by 10% from the current average of 540 days the time interval between reference period (the time to which the data refer) and reporting of data. **FY 1999 Result**: ***This goal was achieved.*** The average time interval decreased to 485 days.
	Goal 5.b	Achieve customer satisfaction ratings with the relevance of products offered of at least 45% "excellent" and at least 90% "excellent" or "good". FY 1998 baseline is 38% "excellent" and 88% "excellent" or "good" from a 1996 customer service survey. **FY 1999 Result**: ***This goal was achieved.*** Customer satisfaction ratings were 60% "excellent" and 90% "excellent to good".

FY 1999 Annual Performance Goals and Results for INVESTMENT

Performance Area	FY 1999 Annual Performance Goal
Proposal and Award Processes	
Use of Merit Review	**Goal 6** At least 90 percent of NSF funds will be allocated to projects reviewed by appropriate peers external to NSF and selected through a merit-based competitive process. FY 98 Baseline: 90%. FY 1999 Goal: 90%. **FY 1999 Result:** ***This goal was achieved.*** 95% of projects allocated funds in FY 1999 were merit reviewed.
Implementation of Merit Review Criteria	**Goal 7** NSF performance in implementation of the new merit review criteria is successful when reviewers address the elements of both generic review criteria appropriate to the proposal at hand and when program officers take the information provided into account in their decisions on awards; minimally effective when reviewers consistently use only a few of the suggested elements of the generic reveiw criteria although others might be applicable. **FY 1999 Result**: ***Largely successful, needs improvement.*** In FY 1999, a total of 44 reports by external experts rated NSF on their use of the new merit review criteria. NSF was rated successful in achieving this goal by 36 of those reports.
Customer Service -- Time to Prepare Proposals	**Goal 8** 95% of program announcements and solicitations will be available at least three months prior to proposal deadlines or target dates improving upon the FY 1998 baseline of 66%. **FY Result:** ***This goal was not achieved***; 75% of program announcements and solicitations were available at least three months prior to proposal deadlines or target dates.
Customer Service -- Time to Decision	**Goal 9** Process 70% of proposals within six months of receipt improving upon the FY 1998 baseline of 59%. **FY 1999 Result**: ***This goal was not achieved***; 58% of proposals were processed within six months of receipt.

FY 1999 Annual Performance Goals and Results for INVESTMENT *(continued)*

Performance Area	FY 1999 Annual Performance Goal	
Award Duration	**Goal 10**	Increase average duration of awards for research projects from a FY 1998 base of 2.7 years to at least 2.8 years. **FY 1999 Result:** ***This goal was achieved.*** The average duration of awards for research grants was increased to 2.8 years in FY 1999. This goal will be replaced in FY 2000 with a goal on customer service.
Maintaining Openness in the System	**Goal 11**	NSF will increase the percentage of competitive research grants going to new investigators to at least 30%, 3% over a baseline of 27%. **FY 1999 Result:** ***This goal was not achieved;*** 27% of competitive research grants were made to new investigators.
Emerging Opportunities		
Identifying Emerging Opportunities	**Goal 12**	All directorates within NSF will establish Web sites for the science and engineering community to provide suggestions for and comment upon emerging opportunities. **FY 1999 Result:** ***This goal was achieved.*** Web sites for providing suggestions and comments on emerging opportunities were established by all directorates at NSF in FY 1999.
Integration of Research and Education		
Encouraging Integration of Research and Education	**Goal 13**	NSF will ensure that all of its new announcements of opportunities and proposal solicitations will contain an explicit statement encouraging proposers to integrate research activities with improving education or public understanding of science. **FY 1999 Result:** ***This goal was achieved.***
Diversity		
Encouraging Attention to Diversity in all Aspects of NSF Programming	**Goal 14**	NSF will ensure that all of its new announcements of opportunities and proposed solicitations will include a statement encouraging proposers to address improving the participation of underrepresented groups in science and engineering in the course of their research and education activities. **FY 1999 Result:** ***This goal was achieved.***

Facilities Oversight		
Construction and Upgrade	**Goal 15.a**	Keep construction and upgrades within annual expenditure plan, not to exceed 110 percent of estimates. **FY 1999 Result:** ***This goal was achieved.***
	Goal 15.b	Keep construction and upgrades within annual schedule; total time required for major components of the project not to exceed 110 percent of estimates. **FY 1999 Result:** ***This goal was achieved.***
	Goal 15.c	For all construction and upgrade projects initiated after 1996, keep total cost within 110 percent of estimates made at the initiation of construction. **FY 1999 Result:** ***This goal was not applicable in FY 1999.***
Operations	**Goal 15.d**	Keep operating time lost due to unscheduled downtime to less than 10 percent of the total scheduled possible operating time. **FY 1999 Result:** ***The results were inconclusive.*** The data base was under development in FY 1999 and requires further evaluation.

FY 1999 Annual Performance Goals and Results for MANAGEMENT

Critical Factor for Success	FY 1999 Performance Goal	
New and Emerging Technologies		
Electronic Proposal Processing	**Goal 16**	NSF will receive at least 25% of full proposal submissions electronically through FastLane improving upon the FY 1998 baseline of 17.5% **FY 1999 Result:** ***This goal was achieved.*** 44% of full proposal submissions were received through FastLane in FY 1999.
NSF Staff		
Diversity	**Goal 17**	In FY 1999, as all appointments for scientists and engineers are considered, the recruiting organization will demonstrate efforts to attract applications from groups that are underrepresented in the science and engineering staff as compared to their representation among Ph.D. holders in their fields. **FY 1999 Result:** ***This goal was achieved.***
Capability in use of Information Technology	**Goal 18**	By FY 1999, all staff will receive an orientation to FastLane, and at least 95% of program and program support staff will receive practice in using its key modules. **FY 1999 Result:** ***This goal was not achieved;*** 80% of all employees received an orientation to FastLane and 40% of program and program support staff received practice in using its key modules.
Implementation of Management Reforms		
Year 2000	**Goal 19**	NSF will complete all activities needed to address the Year 2000 problem for its information systems according to plan, on schedule and within budget, during FY 1999. **FY 1999 Result:** ***This goal was achieved.***
Project Reporting System	**Goal 20**	During FY 1999, at least 70% of all project reports will be submitted through the new electronic Project Reporting System. **FY 1999 Result:** ***This goal was not achieved***; 59% of all project reports were submitted through the electronic Project Reporting System.

SUMMARY OF ASSESSMENT AND EVALUATION PROCESSES

NSF makes use of qualitative information as well as quantitative data in determining progress toward achieving the Foundation's goals. During FY 1999, NSF established new reporting systems and procedures, reporting guidelines, and templates to enable the collection, assessment, and analysis of the information and data necessary for reporting performance. Data sources for each goal as well as data limitations were identified. Steps to alleviate limitations were also identified. NSF has put in place methods to ascertain data quality problems and is developing methods for correction of the problems. For many of the goals, the data sources are central systems while other goals have required creation of new data/information systems to track programs. NSF has identified areas where complete data was not available for FY 1999 reporting, and is taking steps to modify its data systems, where appropriate. NSF will continue striving to improve its data quality and accuracy by improving processes, systems and data input and collection.

NSF will continue striving to improve its data quality and accuracy by improving processes, systems and data input and collection.

NSF's programs and plans are reviewed throughout the year on a continuing basis by internal staff, senior management, and external advisory committees, to determine whether changes are necessary. Regular reviews also provide useful information for establishing new goals and redirecting efforts. Changes to programs and plans may be necessitated by inability to meet a goal, lack of appropriateness of a goal, or inability to measure a goal. These changes are handled through the performance plans and internal management. Major changes, when necessary, are handled through revisions to the strategic plan.

NSF receives and maintains performance information in the form of reports from the external community through Committees of Visitors (COVs) and Advisory Committees (ACs). COVs and ACs are committees made up of independent external experts from academia, industry, government and the public sector. COVs are subcommittees of directorate advisory committees, whose meetings are subject to Federal Advisory Committee Act rules.

Each year, approximately one-third of NSF's programs are reviewed, so that all programs have been reviewed at the end of a three-year period. COVs and ACs produce reports, which are used in assessing NSF's performance, and provide advice to NSF on needed improvements. These COV reports and advisory committee reports combined with data from internal databases, and with appropriate integration by NSF management, form the basis for NSF's performance reports, performance plans, and strategic plans.

Program Assessment by Committees of Visitors (COVs)

COVs review NSF programs for quality of process and results on a 3-year cycle. COVs have access to all of NSF's information and systems. COVs report to NSF on the integrity and efficiency of the processes for proposal review and the quality of results-the outputs and outcomes of NSF's programs as they appear over time. In FY 1999, COVs were asked to judge whether NSF was successful in achieving Goals 1-4, and in implementing the new merit review criteria (Goal 7). COVs used a standardized reporting template with a set of questions addressing process, program management, and quality of outcomes to conduct their assessment of NSF programs. COVs also report on the noteworthy achievements of each year, ways in which projects have collectively affected progress, and expectations for future performance. The recommendations of COVs are reviewed by management and taken into consideration by NSF when evaluating existing programs and future directions for the Foundation. COV reports are public documents, available upon request.

Directorate Assessment by Advisory Committees

Directorate Advisory Committees, composed of external experts who have broad experience in academia, industry, and government, annually review the COV reports, available external assessments, and directorate annual reports, judging program effectiveness, and describing strengths and weaknesses. Directorate annual reports are a balanced representation of the directorate's activities for the fiscal year, including results of COV reports and results from programs not reviewed by COVs in the fiscal year. Advisory committees have full access to a variety of data sources. Advisory committees use the combined COV reports and directorate annual reports as the basis for a strategic planning discussion. NSF management reviews the advisory committee reports and integrates the assessments into the NSF Annual Performance Report.

Integrating NSF's Performance Report

The COV reports and advisory committee reports form the basis for reporting outcome goal results. Examples of outcomes are also selected from directorate annual reports, and other sources such as project reports, newspaper articles, publications, or other reports. NSF management integrates the results of the investment process goals and management goals with the outcome goals to produce this report. The resulting information is also used in preparing the annual performance plans and strategic plans.

SUMMARY OF FINDINGS FROM PROGRAM ASSESSMENTS AND EVALUATIONS

Each year, independent external experts review approximately one-third of NSF's programs. In FY 1999, NSF's activities were organized into nearly 200 programs. Approximately 40% of NSF's program activities were evaluated in FY 1999 by external committees such as committees of visitors (COVs) and advisory committees (ACs). In addition to the reviews and assessments by COVs and ACs, further evaluations of programs are carried out by independent contractors to address issues specific to those programs.

Approximately 40% of NSF's program activities were evaluated in FY 1999 by external committees such as committees of visitors (COVs) and advisory committees (ACs).

In FY 1999, a total of 18 committees of visitors (COVs) met to conduct reviews of 82 programs, producing a total of 43 COV reports assessing the quality of program performance and outcome results. The number of COV reports is greater than the number of COVs because the COVs were organized into subgroups to produce reports covering more than one program. Eight advisory committees met in early FY 2000 to review the work of the COVs and provide additional assessment.

The COVs assess the programs for integrity and efficiency of process and management; quality of science; quality of outputs and outcomes; and implementation and use of merit review criteria, covering a three-year period. This assessment specifically addresses the performance of NSF programs with respect to the outcome goals, the Government-wide goal on the balance of innovative, risky, and interdisciplinary research; and on the NSF goal relevant to the implementation of the new merit review criteria. The program assessments reported by COVs are reviewed and approved by external advisory committees.

Table 1 summarizes the program assessments and evaluations that were completed in FY 1999 in addition to the assessments carried out by the COVs and the advisory committees. The National Science Board also commissioned a study by the Fleet Review Committee, to report to NSF on the Academic Research Fleet. The committee was asked to review and evaluate the current and projected research vessel fleet within a national framework, to review the overall management structure and existing capabilities, and review possible changes to ensure optimal operations.

Program Assessments and Evaluations Completed in FY 1999 Table 1

Program	Scope	Methodology	Goals Addressed
Graduate Research Fellowships Program (GRF)	Determine program effectiveness and participant academic and professional achievement.	External review by independent contractor	**Goal 3**
Faculty Early Career Development Program (CAREER)	Determine use of funds by recipients; document recipients' histories and outcomes; determine value of award within department; determine NSF's effectiveness in implementing and managing the program.	External review by independent contractor	**Goal 3**
Presidential Faculty Fellows Program (PFF)	Determine utility of data from PFF web sites and annual reports.	External review by independent contractor	**Goal 3**
Instructional Materials Development Program (IMD)	Determine quality and use of IMD products in classrooms	External review by independent contractor	**Goal 4**
Experimental Program to Stimulate Competitive Research (EPSCoR)	Determine whether participants increased their share of federal academic research funds from 1980-1994; Identify program strategies responsible for improving participant competitiveness.	External review by independent contractor	**Goals 1-4**

PERFORMANCE RESULTS

Results for Outcome Goals

In this section, we describe how the taxpayer benefits from long-term investments made in NSF's programs. Assessment of NSF's performance is mostly retrospective. This is because research results appear long after an investment is made. Therefore, outcome results reported in FY 1999 are from investments made prior to 1999. We expect that results of FY 1999 investments will not begin to be reported until late FY 2000 and beyond.

...FY 1999 reports from external evaluators consistently judged NSF's programs to result in high quality scientific outputs and outcomes, and to be largely successful in achieving NSF's performance goals.

Each of NSF's long-term outcome goals addresses how the investments made by programs in earlier years have led to results important to the broad mission of the agency.

NSF's outcome goals do not lend themselves to quantitative reporting and therefore NSF has developed an "alternative format" – a qualitative scale that allows NSF to report whether the agency has been "successful" or "minimally effective" in achieving its outcome goals. In FY 1999, approximately 40% of NSF's programs were evaluated by committees of independent external experts, who assessed progress of the programs in achieving NSF's first four outcome goals as either successful or minimally effective.

In summary, FY 1999 reports from external evaluators consistently judged NSF's programs to result in high quality scientific outputs and outcomes, and to be largely successful in achieving NSF's performance goals. Exceptions were noted in some areas as needing improvement including (i) need to improve balance of portfolio by taking more risk (government-wide goal) in a few programs; (ii) need to show increases in participation of underrepresented groups in science and engineering in some programs; and (iii) need to improve use of the new merit review criteria in some programs.

Table 2 Successful COV and AC ratings for each outcome goal assessed using the alternative format. Total possible number of COV report ratings is 43. Total possible number of AC report ratings is 8. Shown is the combined total of ratings (COV ratings plus AC ratings) received for each goal.

Table 2

Outcome Goal	Total Combined Ratings (COV+AC)	# Times Rated Successful by COV	# Times Rated Successful by AC	# Times Rated Minimally Effective by COV	# Times Rated Minimally Effective by AC
Goal 1.a	43	35	8	0	0
Goal 2	43	34	8	1[a]	0
Goal 3	44	33	5	4[b]	2[b]
Goal 4.a	22	15	3	4[c]	0

[a] Program was "Potentially successful" for one indicator which was considered to be "Minimally effective".
[b] Programs were rated "Minimally effective" with respect to the indicator for underrepresented groups only, rated successful for the goal overall.
[c] Programs were rated "Minimally effective" or "Potentially successful" with respect to one indicator.

It is important to note that all goals were not rated by all committee reports. For example, only 22 of the 43 reports gave a rating for Goal 4.a. In some cases where the goals were not rated, committee reports indicated that the goals did not apply to the programs under review, or the committee did not have adequate information to provide a rating. Some committees provided a rating without providing information on how they arrived at the rating. In cases where a split rating was given with a qualifying statement that the program could improve, the lower rating is reported for the indicator being rated. Sources of data for each goal as well as issues are described in the section on Verification and Validation.

The following discussion of NSF performance results includes a sample of the many noteworthy achievements reported by NSF programs in FY 1999. The examples, selected to cover the full range of activities supported by NSF, illustrate the impact and success of NSF's programs in achieving the Foundation's outcome goals. The examples of outcome results presented here have been selected as significant examples from COV and AC reports. In each case a grant number issued by NSF can be used to identify the example for purposes of verification.

Outcome: **Discoveries at and across the frontier of science and engineering.**

FY 1999 Performance Indicators

Level of outputs, quality of outputs, importance of discoveries, introduction of new ideas, development of new tools and technologies, interplay of disciplinary and interdisciplinary research, balance of the portfolio.

1999 Performance Goal 1.a

NSF is **successful** in meeting this goal when, in the aggregate, NSF grantees: (1) make important discoveries; uncover new knowledge and techniques, both expected and unexpected, within and across traditional boundaries; and (2) forge new high-potential links across those boundaries. NSF is **minimally effective** when there is a steady stream of outputs of good scientific quality.

1999 Results

Successful. In FY 1999, 35 COV and 8 AC reports rated NSF for this goal. All reports rated NSF successful in achieving this goal.

This goal will be maintained for FY 2000.

Key Strategy: NSF's key strategy for achieving this goal is to support the most promising ideas in research and education, as identified through merit review of competitive proposals. Innovation and creativity, cooperative research through partnerships, and education and training are emphasized and encouraged.

NSF supports cutting edge research which yields new discoveries over time. These discoveries are essential for maintaining the nation's capacity to excel in science and engineering and they lead to new and innovative technologies, which benefit society.

Areas of Emphasis in FY 1999

The FY 1999 government-wide performance plan contains a performance goal that is particularly relevant to NSF research and education programs and is an area of emphasis in FY 1999:

FY 1999 Government-wide Goal

1999 Performance Goal 1.b

An independent assessment will judge NSF research programs to have the highest scientific quality and an appropriate balance of projects characterized as high-risk, multidisciplinary, or innovative.

1999 Result

This goal was achieved. In FY 1999, all COV reports indicated that NSF programs have high scientific quality. Of the 30 COV reports that gave an opinion on balance of projects in the programs under review, 24 reports indicated that the balance was appropriate. Six reports indicated that the programs under review did not have appropriate balance, with lack of high risk being the most frequent concern. Two of the six critical reports indicated that the programs lacked innovation.

This goal will be maintained as an area of emphasis for FY 2000. To address the concerns raised, NSF staff will be asked to make investments that address this goal, and will strive to identify high-risk projects for reviewers and evaluators. NSF is looking at how to improve the indicators for this goal, and how to provide better data to evaluators of this goal for FY 2000.

In FY 1999, NSF emphasized broad themes including Knowledge and Distributed Intelligence (KDI), Life and Earth's Environment (LEE), and Educating for the Future (EFF). In implementing focused research activities in these areas, NSF works in partnership with other agencies.

Additional areas of emphasis in FY 1999 included:

- New types of scientific databases and the tools to use them. This is a critical component of activity under Knowledge and Distributed Intelligence, an area of emphasis for FY 1999.

- Life in Extreme Environments, which began as a focused investment theme in FY 1997 and is part of Life and Earth's Environment.

- Nanoscience and Engineering, an activity of importance to NSF which spans the agency.

Examples

The following examples illustrate the impact and success of NSF's programs in achieving discoveries and the new knowledge and techniques that have been developed. The examples are chosen to address the FY 1999 areas of emphasis across NSF's programs and to demonstrate linkages across traditional disciplinary boundaries through collaborations. Additional examples can be found in the Appendix.

- **Advances in Biology**

  - NSF-funded scientists, using material obtained from a plant virus, determined the three-dimensional structure of part of the molecular machinery responsible for the virus' ability to control the genetic material of a host cell for its own purposes. This structure provides important clues about ways to modify or control replication of viruses in plants and animals.

  - Scientists funded by NSF are studying how insects feeding on plants are controlled by a combination of their natural enemies and limited plant resources. The interactions go beyond a simple predator-prey relationship because of the occurrence of high-order interactions among the various natural enemies. Not only is there a complex of predators acting, but also the predators may attack each other. The ability to predict the combined effect of multiple predators is critical both to the refinement of predator-prey theory and the improved management of severe agricultural pests such as planthoppers.

- **The Nobel Prize in Chemistry**, awarded annually by the Royal Swedish Academy, recognizes major discoveries over the lifetime of the recipient's career and is an indication of the influence that the individual has had to chemistry. The 1999 Prize was awarded to a researcher whose NSF support over a 20-year period has resulted in an understanding of the details of the birth and death of molecules during chemical reactions. Just as the motion of dancers can be frozen in time using the pulsed light from a strobe the motion of molecules during chemical reactions can be followed in time using pulsed lasers-much like a rapid strobe. The work for which the Nobel Prize was awarded used rapid laser pulses only a few femtoseconds in duration. A femtosecond is to a second what a second is to 32 million years. This area of chemical research has been named femtochemistry. This research has begun to uncover the details of reactions that form the basis for important processes ranging from catalysis to vision.

- **National Medal of Science Awardee.** The 1998 National Medal of Science was awarded to an NSF grantee for pioneering work in colloidal and surface phenomena, catalysis, and advanced materials. He is considered one of the world's leading scientists in these fields. The quality and breadth of his work has received outstanding recognition by the scientific community. In addition, he has mentored numerous students who have gone on to outstanding careers in industry and academia. Various NSF research programs have contributed to his research support continuously since the early 1970s. His research resulted in basic understanding that can be used in a wide range of everyday consumer products that are made up of these microscopic particles. Some of the products that have benefited from this advanced knowledge are improved and stable adhesives, paints, cosmetics, and memory and display devices in electronic products. His work on these very minute particles has led to the development of unique materials called "catalysts" that enable petroleum refineries and chemical manufacturing plants to produce improved gasoline and other consumer chemicals. These unique materials help reduce the unnecessary waste of raw materials, energy, and pollution.

- **NSF Research in the Arctic and Antarctic:**

    - Fossil bones of hadrosaur and mosasaur dinosaurs were discovered by NSF-supported researchers on the Antarctic Peninsula. This finding was awarded "Discovery of the Year" by the Royal Geographic Society of London. The findings are important because current knowledge of these dinosaurs is based mostly on North American fossil sites, and includes relatively rare juvenile mosasaurs. Finding the remains of the hadrosaur, a large terrestrial herbivore, is important because the presence of this animal implies a robust and productive vegetation component of the ecosystem.

- An interdisciplinary team funded by NSF found evidence of climate warming in the Arctic, where the ice cover in the Arctic is rapidly diminishing, due to an encroachment of warmer deep water, melting from a warmer atmosphere, and a positive feedback in the air-snow-ice energy exchange.

- The discovery of a fish antifreeze gene has linked evolution with climate history. NSF supported researchers have discovered that fish in the Arctic and Antarctic oceans have independently evolved nearly identical antifreeze proteins from different parent molecules, showing independent but convergent evolution in response to cooling events in both polar regions. In the Antarctic fish, scientists have pegged the origin of the antifreeze protein gene at five to fourteen million years ago, close in time to the estimated freezing of the Antarctic ocean. Studies in molecular genetics show that the fish did not arise from similar ancestral stocks, but independently developed the antifreeze proteins because of similar ocean freezing events that took place in both Polar Regions.

- **Discoveries in How the Young Learn:**

  - **Infant Development:** NSF findings in infant cognition have radically altered our picture of early development. To probe the infant's mind, researchers have used innovative methods that rely on a simple and reliable behavior: infants will look longer at unexpected events. Using this principle, researchers have examined infants' concepts of the "object", and their concept of everyday things (such as a cat, dog, or chair). The research shows that infants know a great deal: they can track objects through space and time, and even as the objects move behind a screen and then become visible again. The infants can enumerate small numbers of objects, suggesting they develop some basic knowledge of numbers at an early age.

  - **Young Children:** NSF supported research is making discoveries in the foundations of algebraic reasoning among young children. Findings suggest that youngsters are capable of mathematics and science learning that greatly exceeds traditional expectations.

  - **Students:** NSF researchers have developed teaching materials and approaches that help youngsters to acquire deeper understanding of the causes of scientific phenomena. Students in the program faced with initial challenges were better able to understand complex phenomena, such as those with multiple causes, resulting in learning that exceeded that of their peers.

- **Digital Libraries:** Noted important discoveries reported in FY 1999 in the area of digital libraries includes linkage analysis to rate document relevance, new models and techniques for image searching, new clustering techniques applicable to both text and image data, and new techniques for searching and indexing video. These awards and others have led to important discoveries through techniques that increase the usability of digital library materials. As methods are developed by specialists, their potential for use by the general public increases as more people have access to and the skills needed to use digital materials.

Outcome: **Connections between discoveries and their use in service to society.**

FY 1999 Performance Indicators

Availability of results of NSF awards to potential users, use of results of NSF awards by researchers and practitioners, role of NSF-sponsored activities in stimulating innovation and policy development.

1999 Performance Goal 2

NSF is **successful** in meeting this goal when in the aggregate, the results of NSF awards: (1) are rapidly and readily available; (2) feed, as appropriate, into education, policy development; or (3) are used by other federal agencies or the private sector. NSF is **minimally effective** when results of NSF awards show the potential for use in service to society, and when activities designed to enhance connections between discoveries and their use in service to society meet the successful standard.

1999 Results

Successful. In FY 1999, 35 COV reports and eight AC reports rated this goal. Of these, 34 COV reports and all AC reports rated NSF successful in achieving this goal. Several COV reports noted that NSF is doing well but could improve in this area. One COV report noted that this goal may require long term data collection.

This goal will be maintained in FY 2000. NSF will review where improvements can be made in FY 2000.

Key Strategy: NSF's key strategy for success in achieving this goal is through the use of the merit review process to make awards for research and education activities that focus on discovery and that create or have the potential for connections with use in service to society. Potential for use in service to society is an element in the merit review criteria established by NSF and used in the decision process leading to an award.

America's national security, economic competitiveness, health, environment, quality of life, and understanding of the world around us depend on taking advantage of discoveries. Discoveries resulting from basic research and education lead to new knowledge, which often cannot be identified at the start of a project. Thus, the connections are not immediately apparent, and may only be realized decades later. The new knowledge frequently leads to applications, which can have a significant impact on society. NSF views the public accessibility of NSF generated results as well as partnerships among government, academia, and industry as critical components for the progress of science and technological innovation.

Areas of Emphasis in FY 1999

In FY 1999, NSF emphasized broad themes including Knowledge and Distributed Intelligence (KDI), Life and Earth's Environment (LEE), and Educating for the Future (EFF). In implementing focused research activities in these areas, NSF works in partnership with other agencies. FY 1999 areas of emphasis include:

- Plant Genome Research, consistent with the 1998 National Science and Technology Council report on "National Plant Genome Initiative" This activity focuses on completing the sequencing of the model plant *Arabidopsis* (LEE).

- Next Generation Internet, which is an interagency activity aimed at increasing hundred-fold the speed and capacity of today's Internet. NSF's role is to facilitate high-performance links among academic institutions and national centers and to conduct research on networking (KDI).

- Research on Learning and Education, an element of EFF, was given high priority in the report of the President's Committee of Advisors on Science and Technology on the Use of Technology to Strengthen K-12 Education in the United States (March 1997). NSF works in partnership with the Department of Education to build upon past investments.

- Global Change research, within the broad NSF theme of LEE, is done in conjunction with NSF's participation in the U. S. Global Change Research Program.

Examples

The following examples illustrate the impact and success of NSF's programs in achieving important connections between discoveries in FY 1999. Additional examples can be found in the Appendix.

- **Predicting Storms:** Local high-impact weather causes economic losses in the United States that average $300 million per week, impacting over 10% of the U.S. economy each year. The mission of one NSF-funded center is to demonstrate the practicability of numerical weather prediction of storms and to develop, test, and validate a regional forecast system appropriate for operational, commercial, and research applications. The May 3, 1999 tornado outbreak in Central Oklahoma was used to test the storm model, and included networking, collecting, and processing data from several National Weather Service Doppler weather radars. The project was able to generate short-range high-resolution forecasts that dramatically outperformed the National Weather Service forecast during the tornado outbreak. As this forecasting capability is further developed, it will become a critical tool in determining which areas will be most severely hit by storms thereby allowing sufficient and timely warnings to be issued to persons in affected areas. Who stands to benefit? The commercial airlines industry, power and communications industries, surface transportation, agriculture, defense and space flight, construction, insurance and recreation industries will clearly benefit, as well as the National Weather Service and the general public.

- **Oceanographic Research in Service of Fisheries Management:** Over the past decade, there have been dramatic decreases in fish populations in the major fisheries of the United States and Canada including the Cod and Haddock fisheries of the eastern seaboard from the Grand Banks to George's Bank. These decreases have had disastrous economic and societal consequences. NSF spearheaded a U.S. research program whose goal is to predict changes in the distribution and abundance of marine species as a result of changes in their physical and biotic environments as well as to anticipate how their populations might respond to climate change. The program will provide information to fisheries organizations so they may better preserve stocks.

- **Practical Application of Digital Library:** Research in digital libraries led to practical technology exploited in many different areas: the FBI applied digital library (DL) technology to establish an "electronic reading room" to comply with the Freedom of Information Act. State agencies applied digital library technology; for example the California Department of Transportation applied DL to roadside vegetation, quasi-real-time tracking of road conditions, and flood-related emergency services.

- **Global Change Research and Life in Extreme Environments:** Results from a large, long-term interdisciplinary study involving eight natural and social science disciplines have provided a combined assessment of the effects of a predicted global warming, oil development, tourism, and government cutbacks on the sustainability of Arctic villages in the range of the porcupine caribou herd. The effects of global change on the tundra food sources for caribou on the Alaskan north slope and elsewhere are critically important to local native villages where a subsistence lifestyle is practiced either as a necessity for survival or as a cultural choice.

- **Bill Nye the Science Guy**, an NSF supported television series was awarded several Emmy's in 1998-1999, including Outstanding Children's Series, Outstanding Directing in a Children's Series, Outstanding Achievement in Single-Camera Editing, and Outstanding Achievement in Sound Editing. The series resulted in increased comprehension and application of science facts and concepts among its child viewers, who were able to provide more complete and complex explanations of scientific concepts. Based on the size of the audience it reaches, Bill Nye the Science Guy is one of the most popular elements in NSF's informal science education programming.

- **EPSCoR States Linked in Virtual Community:** An alliance developed by six EPSCoR states in the Great Plains enables scientists in these states to link together as a "virtual community" to conduct competitive research on large-scale scientific problems such as "grand challenges". For example, one group analyzes "landsat" data obtained through a land imaging data center in one of the states, and redistributes the results to the agricultural industry and other groups for crop prediction. EPSCoR state researchers in cosmology, astronomy and high-energy physics collaborate with researchers in Europe on questions dealing with structural features of the universe.

- **Assessing Risk to Biodiversity:** NSF funded researchers have developed a new approach for assessing risk to Biodiversity and prioritizing conservation strategies. The approach uses increasingly detailed published and field information to identify the species in a planning area that are most at risk and the places in the landscape most important for those species. The approach was demonstrated in the Greater Yellowstone Ecosystem and a conservation scheme derived that integrated management across public and private lands. The USDA Forest Service is now developing a project to apply the method across the Northern States Region.

Outcome: **A diverse, globally-oriented workforce of scientists and engineers**

FY 1999 Performance Indicators

Demographic data on participants in NSF-funded activities and in the workforce; character of experiences in NSF-funded activities aimed at educating the next generation of the workforce.

1999 Performance Goal 3

NSF is **successful** in meeting this goal when in the aggregate: (1) participants in NSF activities experience world-class professional practices in research and education, using modern technologies and incorporating international points of reference; (2) academia, government, business, and industry recognize their quality; and (3) the science and engineering workforce shows increased participation of underrepresented groups. NSF is **minimally effective** when opportunities and experiences of students in NSF-sponsored activities are comparable to those of most other students in their fields; and when the participation of underrepresented groups in NSF-sponsored science and engineering projects and programs increases.

1999 Results

Successful. In FY 1999, 36 COV reports and 8 AC reports rated this goal, with 33 COV reports and 5 AC reports rating NSF successful in achieving all or most areas of the goal. One AC report gave NSF a qualified successful rating, and four COV reports and 2 AC reports indicated that NSF should do more in the area of showing increased participation of underrepresented groups. Some reports noted that the data necessary to measure this goal were not always available, and more outreach by NSF is necessary to address this goal.

This goal will be maintained in FY 2000. NSF is reviewing where improvements can be made to more fully achieve this goal in FY 2000 and FY 2001. Presently, NSF is not able to collect complete data necessary to measure this goal in a quantitative way, due to restrictions on collecting the data. NSF is working to identify other means to measure the participation of these groups.

Key Strategy: One of NSF's key strategies for success in achieving this goal is to provide opportunities for participation in integrative research and education experiences. To influence the development of integrated approaches, NSF has established a number of Foundation-wide programs intended to synergize the integration of research and education. Each of these programs relies on NSF's close interaction with the academic science and engineering communities to draw research and education together. NSF works to achieve this goal by making awards for research and education activities which are intended to influence the development of the science and engineering workforce, and increase the participation of underrepresented groups.

NSF programs provide only a relatively small portion of the overall U.S. investment in the development of the science and engineering workforce. However, this small investment is particularly important to the development of the workforce of the future. The quality of the future workforce is dependent on the investment being made now to educate and train students. A diverse science and engineering workforce that is representative of the American public and able to respond effectively to a global economy is vitally important to America. As a nation, we need new technical knowledge and people trained to use that knowledge. The competence and capabilities of the nation's science and engineering workforce keep America at the forefront of innovation and technological progress.

Areas of Emphasis in FY 1999

In FY 1999, NSF emphasized broad themes including Knowledge and Distributed Intelligence (KDI), Life and Earth's Environment (LEE), and Educating for the Future (EFF). In implementing focused research activities in these areas, NSF works in partnership with other agencies. FY 1999 areas of emphasis include:

- Providing opportunities for participation in integrative research and education experiences.

- Increasing the participation of underrepresented groups in integrative research and education experiences.

Examples

The following examples illustrate the impact and success of NSF's programs in achieving this goal in FY 1999. Additional examples can be found in the Appendix.

NSF programs contribute to this goal by enabling outstanding education and training opportunities in all areas of science, engineering, education, and technology. In the past year, 900 of the Nation's top graduate students were awarded NSF Graduate Research Fellowships. Of these, 49% were to women and 8% were to minorities. Since 1993, NSF has supported 1,355 graduate research trainees, of which 37% were females and 8% were African Americans, both proportionately higher percentages than national enrollment statistics indicate. During this same period, more than 1,300 NSF graduate research trainees authored or co-authored 1,466 scientific articles, 171 book chapters, 31 books, and applied for 15 patents.

State-of-the-art training opportunities at 42 new technical training sites reached over 700,000 students. Research Experiences for Undergraduates, in nearly all of the fields that the Foundation supports, were available to students at more than 300 sites in 46 states. A new teaching fellows program that offers science majors experience in K-12 classrooms supported about 300 graduate students and 100 undergraduates in its first year of operation.

In FY 1999, several NSF programs supported K-12 science and engineering outreach activities, with one program alone impacting more than 300 teachers and 11,000 students from states across the nation. Another program to increase participation of girls in science and technology careers documented approximately 1,000 teachers indirectly trained by the program through knowledge transfer. The total number of girls likely to be impacted by this program is estimated to be approximately 10,000.

Programs sponsored by NSF are bringing high-quality science education to more than 70,000 future teachers, and enhancing the professional development of more than 150,000 teachers who are already in the classroom. These activities will help to address a projected need for more than 200,000 new secondary mathematics and science teachers over the next decade. This estimate is based on Department of Education projections of aggregate numbers of teachers needed and the current proportion of teachers who are teaching secondary mathematics and science.

Outcome: **Improved achievement in mathematics and science skills needed by all Americans.**

FY 1999 Performance Indicators

Models and practices to improve achievement, teacher training, teacher classroom work, and student achievement**.**

1999 Performance Goal 4.a

NSF is judged to be **successful** in meeting this goal when, in the aggregate, the results of NSF awards lead to: (1) the development, adoption, adaptation, and implementation of effective models, products, and practices that address the needs of all students; (2) well-trained teachers who implement standards-based approaches in their classrooms; and (3) improved student performance in participating schools and districts. NSF is **minimally effective** if NSF awards lead to the development and adaptation of effective educational models, products, and practices; train and further develop teachers in the standards-based approaches; and prevent further deterioration in student achievement in participating schools and districts.

1999 Results

Successful. In FY 1999, 19 COV reports and 3 AC reports rated NSF for this goal. Of these, 15 COV reports and 3 AC reports rated NSF successful in achieving this goal in all or most areas of the goal. Four COV reports indicated NSF was not fully successful in some areas of this goal. This goal is viewed by many COVs and ACs as being more applicable to NSF's educational activities. Therefore, many reports did not rate programs for this goal unless the program had a clearly identified activity which applied to this goal.

This goal will be maintained in FY 2000. NSF is reviewing where improvements can be made to more fully achieve this goal in FY 2000 and FY 2001.

Key Strategy: NSF's key strategy for achieving this goal is through the use of the merit review process to make awards for the most promising activities that have the potential to produce the greatest impact. NSF supports a continuum of activities that enable improvement of mathematics and science skills for all Americans. These activities include educational reform at the K-12 levels and beyond; teacher education and professional development; research activities that use science and technology to inform better educational practice; and activities that bring science into the classroom and place students at the sites of exploration and discovery. Common themes that are emphasized across the Foundation include the implementation of high quality, standards-based instruction for all students; integration of research and education; and coordination of resources, policies, and practices to maximize the impact of educational investments. These activities benefit students, teachers, and the general public nationwide. NSF has established linkages with other agencies, and supports the development of prototypes for cooperative activities involving state and local educational agencies, and the private sector.

This goal addresses a need widely recognized by all Americans. Proficiency in essential skills and understanding of basic concepts in mathematics and science are critical to the earning power of individuals, to the nation's economic competitiveness, and to the quality of life in the 21st century. NSF is the only federal agency that directly aims at developing such proficiencies at all levels of education.

Investments in education are made to facilitate the development of essential skills in mathematics and science for all Americans through the promotion of broad-based or system-wide reforms in science, mathematics, engineering, and technology education that are based on national standards. Important for FY 1999 are projects that include systemic approaches, attention to teacher preparation and development, partnership with other agencies, and development of a strong research base for use by practitioners.

Areas of Emphasis in FY 1999

NSF's activities under the theme of Educating for the Future include several areas of emphasis focused on improving achievement in mathematics and science skills, and two quantitative goals taken from the 1999 government-wide performance plan.

The FY 1999 government-wide performance plan contains two quantitative performance goals that are particularly relevant to performance in this area. Both are related to NSF's systemic activities in K-12 education. At the start of the decade, NSF initiated major programs for the systemic reform of science, mathematics, engineering, and technology education. Based on the belief that all students can learn and achieve in science and mathematics at much higher levels than then obtained, systemic projects treat whole systems and build much-needed educational capacity at state, urban, rural, school district, and school levels. These projects are unique in their involvement of broad partnerships and development of comprehensive goals, solutions, and actions.

FY 1999 Government-wide Performance Goals

Performance Goal 4.b

Over 80 percent of schools participating in a systemic initiative program will (1) implement a standards-based curriculum in science and mathematics; (2) further professional development of the instructional workforce; and (3) improve student achievement on a selected battery of tests, after three years of NSF support.

FY 1999 Result

In 1999, 40 NSF sponsored projects implemented mathematics and science standards-based curricula in over 81 percent of participating schools, and provided professional development for more than 156,000 teachers. All participating educational systems demonstrated some level of improvement in student achievement in mathematics and science on a battery of system-selected assessment instruments. This goal will be continued for FY 2000.

Performance Goal 4.c

Through systemic initiatives and related teacher enhancement programs, NSF will provide intensive professional development experiences for at least 65,000 precollege teachers.

FY 1999 Result

In FY 1999, systemic initiatives and related teacher enhancement programs provided intensive professional development to more than 82,400 teachers, exceeding the goal of 65,000. This goal will be continued in FY 2000.

Examples

The following examples serve to illustrate the impact and success of some of NSF's programs in achieving improvement in mathematics and science skills, including areas of emphasis in FY 1999. Additional examples can be found in the Appendix.

NSF-supported activities benefit students, teachers, and the general public nationwide. For academic year 1998, NSF education reform efforts in states, urban centers and rural areas covered 38 states, and the commonwealth of Puerto Rico. A total of 19,000 schools, more than 156,000 K-12 mathematics and science teachers, and more than 11 million K-12 students benefited from these programs. Informal education through exhibits, radio, television, film, and youth and community-based activities reach over 150 million people – more than half of all Americans – every year.

In the area of mathematics at the elementary and middle school levels, the enhanced quality of professional development activities, coupled with increased course-taking requirements in areas such as algebra, geometry, and measurement, resulted in significant improvement in student achievement. For example:

- For participating Dallas students, mathematics gains exceeded expectations in seven of eight grades. For grades 3-8, the schools participating over a five-year period out-performed their statewide counterparts on a state mathematics test at five of the six grade levels tested.

- In Philadelphia, student scores in mathematics and science increased for three grades being tested - 4, 8, and 11, according to the results of a national assessment tool used by major school systems to cover core academic subjects. For example, at grade 4 the percentage of students demonstrating science proficiency increased from 40% in 1996 to 49% in 1998.

Bringing Kids to Research through the Internet:

- **Chickscope** is the result of an interdisciplinary program that puts magnetic resonance imaging (MRI) technology into K-12 classrooms through the Internet. *Chickscope* enables teachers and students to access and operate an MRI system on a web-site, to peer inside a chick embryo and observe its development over the 21 days it takes for the egg to mature.

- **Bugscope** is the result of a major research instrumentation award which allows students to use a remote-controlled microscope that magnifies more than 5000 times, to see what makes bugs tick. Bugscope is a nationwide science program developed by researchers as an innovative way for students to see that the study of science can be fun and exciting.

Outcome: **Timely and relevant information on the national and international science and engineering enterprise.**

Performance Indicators

Timeliness: Average time interval between reference period (the time to which the data refer) and reporting of data. **Relevance:** Customer satisfaction ratings for the relevance of products offered.

1999 Performance Goals

NSF is **successful** in meeting this goal when:

Goal 5.a the average time interval between the reference period (the time to which the data refer) and the reporting of data decreases by 10% from the baseline; and

Goal 5.b customer satisfaction ratings are achieved for the relevance of products offered of at least 45% “excellent” and at least 90% “excellent” or “good”.

1999 Results

Successful. Both the timeliness and the relevance goals were achieved. For timeliness, the average time interval decreased to 485 days. For relevance, customer satisfaction ratings were 60% "excellent" and 90% "excellent to good".

The **Timeliness** goal will be maintained for FY 2000. The **Relevance** goal will be replaced in FY 2000 with a goal on data quality. Data quality is one factor in addressing relevance.

These goals address NSF's legislative mandate to collect, interpret, and analyze data on scientific and engineering resources, and to provide a source of information for federal policy formulation. NSF works closely with other Federal agencies, academic institutions, industry, foreign, and multi-national organizations to identify and meet key data needs for policy decision making. In a recent survey, a sample of the science and engineering policy community indicated that improving the *timeliness* of data was a high priority for them. The value of information on the science and engineering enterprise is highly dependent on its *relevance* to those who seek to use it in making policy decisions. Different users are interested in different aspects of the enterprise. Key products include congressionally mandated reports, statistical reports from national surveys, special topic reports, and public use databases. The performance goals for this activity aim for improved quality through enhanced timeliness and enhanced attention to data quality measures.

Timeliness Goal average time interval between the reference period and the public release		
Baseline (1995-96)	**FY 1999 Goal**	**FY 1999 Result**
540 days	486 days	485 days

Timeliness: For survey data released in FY 1998 and FY 1999, NSF achieved the FY 1999 goal of improving timeliness. To measure this goal, data are collected which refer either to a specific date or period of time. A reference date is calculated as the last day in the period. The time between the reference date and the first public release of data for each survey is calculated, and then an average is taken across all surveys over a two-year period. This goal will be maintained for FY 2000.

Relevance Goal [1]			
Relevance of Products	**Baseline (1996)**	**FY 1999 Goal**	**FY 1999 Result**
Excellent	38%	45%	60%
Excellent or Good	88%	90%	90%

[1] The baseline measure for customer satisfaction is derived from a customer survey conducted in 1996. The ratings of the relevance of the products are based on the two substantive topics (timeliness and accuracy) that individuals indicated in the survey as most important to them.

Relevance - Customer Satisfaction: The baseline measure for customer satisfaction is derived from the customer survey conducted in 1996. The 1996 survey sampled a general group of people on the list of the American Association for the Advancement of Science (AAAS) who had declared an interest in science policy. This group was again surveyed in 1999, using the same items on customer satisfaction as in 1996. The 1999 survey indicated that NSF met or exceeded the thresholds set forth under the FY 1999 Performance Goal for satisfaction with the relevance of NSF products. This goal will be replaced in FY 2000 with a goal on data quality. Data quality is one factor in addressing relevance.

Results for Investment Process Goals

NSF's investment process goals focus on the means and strategies the Foundation uses to make investment decisions and shape its portfolio of awards in order to achieve its mission and desired outcome goals. The investment process goals address various aspects of NSF's awards process, such as the use of merit review and the need to keep the awards system open to new people and new ideas. These goals help to establish customer service standards for the agency, e.g., use of merit review, and improved practices such as the time it takes to process a proposal. In addition, the federal-wide performance goals that focus on facilities oversight are included in NSF's set of investment process goals.

In FY 1999, nine investment process goals were achieved and four were not achieved.

Summary of Results FY 1999 Investment Process Goals	
Investment Goals Achieved	9
Investment Goals Not Achieved	4

Goal 6 - Use of Merit Review

At least 90% of NSF funds will be allocated to projects reviewed by appropriate peers external to NSF and selected through a merit-based competitive process.

Performance Indicator

Percent of NSF funds allocated to projects reviewed by appropriate peers external to NSF and selected through a merit-based competitive process.

Percent of project funding that has undergone merit review

FY 1997	89%
FY 1998	90%
FY 1999 Goal:	**90%**
FY 1999 Result:	**95%**

RESULTS

NSF exceeded this goal, with 95% of project funds allocated to projects subjected to merit review. Merit review is a critical component of NSF's decision making process for funding research and education projects. The Foundation strongly believes that award selections based on a competitive merit review process with peer evaluation ensure those ideas from the strongest researchers and educators will be identified.

Note: Unlike prior year data, the FY 1999 data excludes the Graduate Research Fellowship program. If the Fellowship program were to be included in the FY 1999 data, it is estimated that the result would be slightly less - approximately 92%.

This goal will be maintained in FY 2000. NSF expects to exceed the government-wide goal again.

Goal 7 - Implementation of Merit Review Criteria

NSF performance in implementation of the new merit review criteria is:

- **successful** when reviewers address the elements of both generic review criteria appropriate to the proposal at hand and when program officers take the information provided into account in their decisions on awards;

- **minimally effective** when reviews consistently use only a few of the suggested elements of the generic review criteria although others might be applicable.

Performance Indicator

Use of merit review criteria by reviewers and program staff.

RESULTS

Largely successful, needs some improvement.

In early FY 1998, two new NSF merit review criteria went into effect, replacing four existing criteria. For FY 1999, COV's and AC's used the alternative format to judge how well NSF is implementing the new criteria. In FY 1999, a total of 38 COV reports and 6 AC reports rated NSF programs on their use of the new merit review criteria. NSF was rated successful in achieving this goal in 33 COV reports and 3 AC reports. One AC report gives NSF a qualified successful rating, and two AC reports rate NSF minimally effective in implementing this goal. In most cases where NSF was not fully successful, it was found that reviewers and applicants were not fully addressing both review criteria.

NSF has established guidelines in program announcements requiring applicants and reviewers to address these criteria in proposals and reviews. NSF has recently re-issued guidance to the applicants and reviewers, stressing the importance of using both criteria in the preparation and evaluation of proposals submitted to NSF. NSF is considering taking additional steps to ensure that applicants address these criteria when reporting project results.

This goal will be maintained for FY 2000.

Goal 8 – Time to Prepare Proposals

95% of program announcements and solicitations will be available at least three months prior to proposal deadlines or target dates.

Customer Service Standard

To make program announcements and solicitations available to relevant individuals and organizations at least three months prior to the proposal deadline or target date.

Performance Indicator

Percent of program announcements and solicitations available at least three months prior to proposal deadlines or target dates.

Percent of program announcements/solicitations available at least 3 months prior to deadline/target dates: [Prior data not available]

FY 1998 Baseline:	66%
FY 1999 Goal:	**95%**
FY 1999 Result:	**75%**
FY 2000 Goal:	95%

RESULTS

This goal was not achieved. This customer service standard was established in response to a survey where NSF applicants revealed that having a minimum of three months between program announcements and proposal deadlines was valued highly. In FY 1999, 75% of program announcements and solicitations were made available at least three months prior to their deadline/target date. Another 4% came within a few days of the three-month period.

NSF intends to conduct an assessment of the FY 1999 data to determine why more announcements were not made available three months prior to deadline/target dates. NSF intends to focus additional efforts in this area to correct identified bottlenecks in the announcement posting process. In FY 2000, a web-based system for creating program announcements has been put in place; this system is expected to decrease the time required for an announcement to be posted on the NSF web site, which should aid the agency in achieving this goal.

Goal 9 – Time to Decision

Process 70% of proposals within six months of receipt.

Customer Service Standard

For 95 percent of proposals, be able to tell applicants whether their proposals have been declined or recommended for funding within six months of receipt.

Performance Indicator

Percent of proposals processed within six months of receipt.

Percent of proposals processed within six months:

FY 1994	50%	
FY 1995	49%	
FY 1996	42%	
FY 1997	61%	**FY 1999 Goal 70%**
FY 1998	59%	**FY 1999 Result 58%**

RESULTS

This goal was not achieved. This customer service standard was established in response to a survey of NSF applicants who indicated that processing proposals within six months of receipt was valued highly. In FY 1999, 58% of proposals were processed within six months of receipt, somewhat better than the 52% average rate over the last five years, but nevertheless short of the 70% goal. NSF recognizes the validity of the community's interest in this customer service standard and is striving to expedite the time between proposal submission and agency decision without jeopardizing the quality and integrity of the review process.

This standard is applicable to research project support and education and training. However, the process for research facilities is more extended due to the more complex nature of the projects.

This goal is challenging, and therefore annual performance targets are being scaled to reach the customer service standard by FY 2002. In FY 2000, NSF staff will work towards shortening the award processing time by making more effective use of electronic mechanisms in conducting the review, working cooperatively to eliminate overloads and bottlenecks and carefully tracking the stage of processing and age of all proposals.

This goal will be maintained in FY 2000.

Goal 10 – Award Duration

Increase average duration of awards for competitive research grants from a FY 1998 baseline of 2.7 years to at least 2.8 years.

Performance Indicator

Average duration of awards for research projects.

Duration of awards, in years

FY 1995	2.9 years
FY 1996	2.9 years
FY 1997	2.8 years
FY 1998 Baseline	2.7 years
FY 1999 Goal	**2.8 years**
FY 1999 Result	**2.8 years**

RESULTS

This goal was achieved. Providing an adequate duration for awards is necessary for obtaining high quality proposals and allowing the proposed work to be accomplished as planned. The entire science enterprise benefits when researchers are able to devote more time to research and less time to writing proposals.

This goal is important for the Foundation, but it will not appear in the FY 2000 Performance Plan as a separate goal.

Goal 11 – Maintaining Openness in the System

NSF will increase the percentage of competitive research grants going to new investigators to at least 30%.

Performance Indicator

Percent of competitive research grants going to new investigators.

Percent of research grants going to new investigators

FY 1994	26%
FY 1995	26%
FY 1996	27%
FY 1997	27%
FY 1998	27%
FY 1999 Goal	**30%**
FY 1999 Result	**27%**

RESULTS

This goal was not achieved. NSF believes that it is important that the proposal and award process be open to new people and new ideas, to help ensure that NSF is supporting research at the frontier of science and engineering. NSF is committed to maintaining openness in the system and will strive to increase the percentage of awards to new investigators.

This goal will be maintained in FY 2000, even though it is not clear that the level set for this goal is appropriate for NSF. NSF will review this goal in FY 2000 to determine what level is appropriate, and will evaluate the trend as it evolves, taking management action as appropriate.

Goal 12 – Identifying Emerging Opportunities

All directorates within NSF will establish Web sites for the science and engineering community to provide suggestions for and comment upon emerging opportunities for significant advances in disciplinary and interdisciplinary fields of exploration; innovative research facilities; and new approaches to education and training.

Performance Indicator

Active web sites that seek input on emerging opportunities.

RESULTS

This goal was achieved. During FY 1999, each NSF directorate Web site included a solicitation for suggestions and comments about emerging opportunities for significant advances in disciplinary and interdisciplinary fields of exploration; innovative research facilities; and new approaches to education and training. NSF believes that identifying and acting upon emerging opportunities in science and engineering is a basic strategy that supports all of NSF's outcome goals for research and education. NSF is committed to engaging the community in an ongoing dialogue in order to assure that priorities for future funding are established properly.

This goal will not be continued in the FY 2000 Performance Plan since the sites are in place and open to comment.

Identifying and acting upon emerging opportunities in science and engineering is another basic strategy that supports all of the outcome goals for research and education. NSF uses many mechanisms to assist in the identification of areas of emerging opportunity: advisory committees, special workshops, interaction with elements of the National Research Council, proposal review panels, and even the proposals themselves.

Goal 13 – Encouraging Integration of Research and Education

NSF will ensure that all of its new announcements of opportunities and proposal solicitations will contain an explicit statement encouraging proposers to integrate research activities with improving education or public understanding of science.

Performance Indicator

Coverage of integration of research and education in NSF announcements of opportunities and proposal solicitations

RESULTS

This goal was achieved. During FY 1999, all new NSF proposal announcements and solicitations included a statement requesting that proposers address how their work would integrate research activities with education activities. NSF is interested in having awardees pay deliberate attention to their effectiveness as both researchers and educators. In the long run, the interaction of research and education will provide for the development of a science and technology workforce as well as draw academic scientists and engineers into the challenge of improving K-12 education. In FY 2000, NSF will develop a plan and system to request that Principal Investigators (PIs) address the integration of research and education in their proposals, and develop and implement a system to verify that PIs have done so.

This goal is being expanded upon in FY 2000 by taking it to the next phase of implementation with two new goals on this topic. The two new goals will focus the proposers and reviewers on the integration of research and education and its importance to the Foundation.

Integrating research and education appears as part of the investment strategies supporting all of the outcome goals for education and research as described in NSF's GPRA strategic plan. NSF expects to see continuous improvement in the extent to which its research and education functions are accomplished jointly. The long term objective is two-fold: (1) to renew the strong interaction between federally-funded academic research and the development of the science and technology workforce that has characterized the U.S. science and engineering enterprise; and (2) to draw academic scientists and engineers into the challenge of improving K-12 education. We want to see all our awardees pay deliberate attention to their effectiveness as both researchers and educators.

Goal 14 – Encouraging Attention to Diversity in all Aspects of NSF Programming

NSF will ensure that all of its new announcements of opportunities and proposal solicitations will include a statement encouraging proposers to address improving the participation of underrepresented groups in science and engineering in the course of their research and education activities.

Performance Indicator

Coverage of diversity in NSF announcements of opportunities and proposal solicitations.

RESULTS

This goal was achieved. During FY 1999, all new NSF proposal announcements and solicitations included a statement that asked proposers to address how their proposed research and education activities encourage the participation of underrepresented groups in science and engineering. NSF emphasis on diversity responds to the legislative requirement that NSF address issues of equal opportunity in science and engineering.

This goal will be slightly revised in FY 2000. In FY 2000, NSF will identify mechanisms to increase the number of underrepresented minorities in the proposal applicant pool, and will identify mechanisms to retain that pool.

In 1980, legislation gave NSF explicit responsibility for addressing issues of equal opportunity in science and engineering. This assignment of responsibility reflected the serious underrepresentation of women, minorities, and persons with disabilities in the science and engineering workforce, underrepresentation that persists to this day, although some progress has been made. Recognizing that progress toward all outcome goals for research and education requires maximal diversity of intellectual thought, NSF is emphasizing attention to enhancing the participation of groups currently underrepresented in science and engineering, including women, underrepresented minorities, and persons with disabilities, in all its programs. The long-term objective is to have a science and engineering workforce that mirrors the U.S. population.

Goal 15 – Facilities Oversight

The following goals are for federal science, space and technology agencies that support construction projects and have responsibility for managing facilities (NSF, NASA, DOE).

CONSTRUCTION AND UPGRADE

Performance Indicators

Comparison with planned annual cost, planned annual schedule, and planned total cost.

GOAL 15.a: Keep construction and upgrades within annual expenditure plan, not to exceed 110% of estimates.

GOAL 15.b: Keep construction and upgrades within annual schedule, total time required for major components of the project not to exceed 110% of estimates.

GOAL 15.c: For all construction and upgrade project initiated after 1996, when current planning processes were put in place, keep total cost within 110% of estimates made at the initiation of construction.

1999 RESULTS

Data indicated that the majority of construction and upgrade projects were within annual expedenture plans and on schedule. During FY 1999, there were no construction and upgrade projects that were completed; therefore, the goal of keeping total project costs within 110% of initial estimates was not applicable. In FY 1999, NSF implemented a new facilities reporting system. In FY 2000, the facilities reporting system will be reviewed and updated to increase efficiency and to improve the reliability of data.

These goals will be maintained in FY 2000.

OPERATIONS

Performance Indicator

Comparison to scheduled operating time.

GOAL 15.d: Keep operating time lost due to unscheduled downtime to less than 10% of the total scheduled possible operating time.

RESULTS

Inconclusive. In FY 1999, NSF implemented a new facilities reporting system. The data base was under development in FY 1999 and the new data required further evaluation based on the first round of data submitted. NSF found that the system requires further refinement in order to verify and validate the data that will be used to assess the goal. In FY 2000, the facilities reporting system will be reviewed and updated to increase efficiency and to improve the reliability of the data.

This goal will be maintained in FY 2000.

NSF provides support for large multi-user facilities, which meet the need for access to state-of-the-art research facilities that are vital to the progress of research. This funding is essential to the development of world-class research capabilities. NSF provides funding for the construction and acquisition of major research facilities that provide unique capabilities at the cutting edge of science and engineering.

NSF has major responsibility for funding the operation of several multiple user facilities, which provide high cost equipment with unique capabilities to many individuals. NSF has provided construction funds for only a few facilities. Such facilities typically cannot be duplicated at more than one site. In addition, NSF puts a high premium on professional initial planning for construction and upgrade of facilities. Planning for unique, state-of-the-art facilities must take into account the exploratory nature of the facilities themselves. Such facilities test the limits of technological capability.

Every year, in the President's Budget Request, NSF sets out a cost plan and schedule for major construction and upgrade projects currently underway or planned for initiation in the Major Research Equipment account. NSF has established performance goals and measurements with respect to these plans and expects each construction and upgrade activity to meet these performance goals.

- NSF consults with other agencies to avoid duplication and to optimize capabilities available to American researchers, and cooperates with other agencies in construction of facilities where it will facilitate use across broad communities of researchers.

- NSF manages facilities in the Antarctic that are used by all federal agencies for selected projects.

- Many major facilities involve international cooperation.

Facilities must operate efficiently and reliably and must offer appropriate opportunities if they are to be valuable to those they serve. NSF program officers work closely with facilities' directors to ensure that facilities have appropriate resources to conduct operations and to provide maintenance that ensures reliable operations.

In order to report on the government-wide performance goals related to Facility Operations, and Construction and Upgrade, NSF developed a new Performance Reporting System (as a module of the existing FastLane system) which was used to collect information of facility operations and construction from Facilities Managers external to NSF. As is the case with any new data collection effort, we expect the quality of the information provided to improve in subsequent years as managers gain experience with gathering and reporting the required data.

NSF plans to review the FY 1999 data collection and reporting effort and will make feasible modifications to the FY 2000 and FY 2001 systems in order to improve the efficiency, clarity and accuracy of the process.

Results for Management Goals

NSF's management goals address the Foundation's administrative, operations and policy issues. NSF's five management goals for FY 1999 emphasize the implementation of information technologies and human resource development– FastLane and the Project Reporting System; staff diversity; staff training; and Y2K compliance- to improve how we do business. Of NSF's five management goals, three were fully achieved. Over the course of the fiscal year, we have gained valuable experience in disseminating, tracking, and reporting the NSF management goals. This experience has led us to refine the FY 2000 goals, and has helped us to focus NSF employees on these management goals. Overall, NSF has been quite successful in meeting its management goals and we expect to show even more improvement in the 2000 fiscal year.

FY 1999 Performance Results for Management Goals	
Mangement Goals Achieved	3
Management Goals Not Achieved	2

Goal 16 – FastLane Proposals

NSF will receive and process at least 25% of full proposal submissions electronically through FastLane.

Percent of proposals submitted electronically through FastLane.

FY 1997 Baseline	4.4%
FY 1998	17%
FY 1999 Goal	**25%**
FY 1999 Result	**44%**

RESULTS

This goal was achieved. FastLane is a collection of system modules that streamline and reengineer all of the Foundation's interactions with the research community. Under development since 1994, the goal is to provide a paperless environment by the end of FY 2001.

This goal was initially set at 10%, and was modified to 25% once data became available in 1998. In FY 1999, 44% of full proposal submissions were received through FastLane, far exceeding NSF's goal of 25%.

During the year NSF pursued an aggressive outreach strategy with the research and education community to educate them on the use and advantages of FastLane, and an external Helpdesk was established to assist our external customers. About 90% of requests for assistance are related to proposal preparation and submission.

A significant number of programs require electronic submission in FY 2000. In light of NSF's success with FastLane, and FY 2000 requirements, the FY 2000 target will be increased to 60%.

Goal 17 – Staff Diversity

In FY 1999, as all appointments for scientists and engineers are considered, the recruiting organization will demonstrate efforts to attract applications from groups that are underrepresented in the science and engineering staff as compared to their representation among Ph.D. holders in their fields.

RESULTS

This goal was achieved. NSF is committed to diversifying its staff of scientists and engineers both in permanent positions and in the important rotating positions. In order to ensure that the United States maintains its world leadership role in science and technology, the nation must maintain in the present, as well as ensure for the future, a premiere cadre of scientists, mathematicians and engineers by tapping into all sectors of society.

In FY 1999, NSF hired a total of 61 scientists and engineers. A wide variety of strategies were utilized to increase the diversity of the applicant pool. This included participation in job fairs targeted to underrepresented groups, mailing vacancy announcements to publications and institutions predominantly serving underrepresented groups, and direct networking on the part of NSF staff. NSF developed a system for collecting information on applicant diversity through the use of a voluntary background survey of applicants as a way to measure this goal. The low rate of return and the voluntary nature of this effort resulted in data that were of little value to the agency.

This goal is being revised for FY 2000, to make the goal more measurable. For FY 2000, the performance goal will be: In FY 2000, NSF will show an increase over 1997 in the total number of hires to S&E positions from underrepresented groups.

Goal 18 – FastLane Training

By the end of FY 1999, all staff will receive an orientation to FastLane, and at least 95% of program and program support staff will receive practice in using its key modules.

Percentage of Staff Receiving FastLane Orientation and Training:

	Orientation	Training
FY 1999 Goal	**100%**	**95%**
FY 1999 Result	**80%**	**43%**
FY 2000 Goal	100%	80%

RESULTS

This goal was not achieved, although NSF made notable progress towards the achievement of this goal. In order for NSF to successfully implement new business systems, particularly systems like FastLane, it is important that all staff be oriented and properly trained.

For FY 1999, 80% of all employees received an orientation to FastLane and 43% of program and program support staff received practice using key modules.

Both the orientation and training targets will be included in NSF's FY 2000 Performance Plan and staff will be strongly encouraged to attend orientation and training sessions.

Goal 19 – Year 2000 Compliance

NSF will complete all activities needed to address the Year 2000 problem for its information systems according to plan, on schedule and within budget, during FY 1999.

RESULTS

NSF achieved this goal for the Year 2000 information systems problem ahead of schedule. Among the activities undertaken in preparation for Y2K were: (1) Having an independent contractor perform an independent validation and verification of application programs. This activity was completed during Spring 1999. (2) Having an independent contractor provide an evaluation of each line of code for potential Year 2000 problems. All Division of Information Systems application code was run through this software. Problems were identified and corrected.

In FY 2000, NSF will complete all activities needed to address the Year 2000 problem for its information systems according to plan, on schedule, and within budget.

Goal 20 – Project Reporting

During FY 1999, at least 70% of all project reports will be submitted through the new Project Reporting System.

RESULTS

This goal was not achieved. The implementation of the new Reporting System is part of the effort by NSF to use advanced technology to create a more efficient, paperless work environment, in which information transmitted between the Foundation and its research and education customer community is done electronically via the Internet. FY 1999 was a transition year for the reporting system. NSF allowed PI's to submit project reports using the old paper report forms for the first three months of the fiscal year. In addition, a paper version of the new electronic reporting format was provided to PI's who could not access the electronic system. We believe the submission rate of 59% to be excellent for a transition year. Based on feedback received throughout the year, modifications to the system have been made. NSF will continue to enhance the system based on user feedback and policy changes.

In FY 2000, this performance goal has been revised: During FY 2000, at least 85% of all project reports will be submitted through the new Project Reporting System.

CONTRIBUTIONS OF NON-FEDERAL PARTIES IN PREPARING REPORTS

Non-Federal parties prepared no portions of this report. Non-Federal parties may have provided information used in this report.

VERIFICATION AND VALIDATION – Collection, Reporting, and Validation of Performance Information and Results

Types and Sources of Performance Data and Information

The data used in reporting NSF's goals are two types of data: (a) non-quantitative information in the form of outputs and outcomes, collected and reported using the alternative format, which are used for the Outcome Goals (Goals 1- 4) and the implementation of the new merit review criteria (Goal 7); and (b) numerical data collected through systems for the performance target levels of the Management and Investment Goals (Goals 6, and 8-20), and NSF's goal on relevant, timely information (Goal 5).

NSF's outcome goals are expressed in the alternative format.

Issues Specific to NSF

Because it is difficult to predict or quantify research results, or to report them in a timely way, NSF's outcome goals are expressed in the alternative format. Research results cannot be predicted beforehand, and the time frame for reporting outcomes is typically long after the fiscal year in which an award was made. For example, a grant provided in one fiscal year might not produce a reportable outcome for five years or more, if at all. For FY 1999, the committees of external experts reviewed programs covering a period starting from before FY 1996, through FY 1999. Therefore, the outcomes reported here in FY 1999 include results from awards which were made prior to and including FY 1999.

To report the level of performance for these goals, we have included examples that illustrate achievements reported during the fiscal year. It should be noted that while NSF made use of the alternative format using the two standard approach required by

the Act ("successful" or "minimally effective"), it was found that there was little to be gained in defining the use of "minimally effective", and that in many instances it was confusing to the evaluators. Therefore, for FY 2000, NSF will define one standard only: the "successful" standard. The programs will be evaluated on whether they are effective in achieving the target goals and on the effectiveness of their impact.

The Investment and Management goals are primarily target levels to be achieved, and lend themselves to quantitative analysis. The Outcome goals are non-quantitative, and make use of the alternative format, which is a qualitative standard. In all cases where the alternative format is used, groups of experts were asked to use their judgement and to provide examples to support their judgement of NSF's performance in achieving a goal. In some reports, committees indicate that complete data necessary to evaluate a goal were not available. In most of these cases the evaluating committee did not provide a rating of performance. In some cases, the experts provided more substantial examples than in others, and in some cases the experts gave an opinion or rated a program without complete information, or without providing complete justification. In some cases, the experts gave a rating, then discussed how they arrived at their rating, which may not have been in agreement with the definitions of NSF's qualitative scale. In a few cases, the experts did not give an opinion, either because they did not find the goal appropriate for the program being assessed, or because they did not have sufficient or appropriate information to give an opinion.

Collection of data is dependent on the type of data/information. Sources of data for each goal are indicated in the table(s) below. Collection of data for all goals takes place throughout the year, and is completed near the end of the fiscal year. Depending upon the specific type of data, data are collected into a report for a given goal by a group responsible for that goal, and then organized for reporting. The data obtained are reviewed on a continuing basis by senior NSF management throughout the year, to observe whether the results are as expected, or need to be improved, or whether to adjust the targets, or whether the information being obtained is useful to the agency. Data collection systems are also under constant observance and refinement, as in the case of the new FastLane reporting system.

A timing issue which NSF has faced in preparing this report may be an issue shared by other agencies. Specifically, the timing and phasing of the annual plan, collection of information and data for reporting, and the budget process have been difficult to coordinate. To optimize our goals for the new fiscal year, we must review our progress from the prior fiscal year, and make revisions to the annual plan for the upcoming year. In FY 1999, we found that the timing needed to collect and review the data for the first

year, and incorporate changes into the FY 2000 annual performance plan in a way which we believe benefits the process, was not available with the current schedule required by GPRA.

Data Sources and Limitations

The sources of data used in the performance report are organized according to each goal relevant to Outcomes, Investment Process, and Management.

NSF sources of data include central databases such as the Electronic Project Reporting System, the Enterprise Information System, the FastLane system, the Proposal system, the Awards system, the Reviewer System, the Integrated Personnel System, the Finance System, and the Online Document System; distributed sources such as scientific publications, press releases, independent assessments including committee of visitor (COV) and advisory committee (AC) reports, program and division annual reports, directorate annual reports, and internally maintained local databases. In a few cases, NSF makes use of externally maintained contractor databases.

Data for Outcome Goals

The results for Outcome Goals 1-4 are in the form of standardized reports collected across all areas of NSF from committees of external experts (COVs and ACs). The data used in reporting the results of achievement are tabulated from COV and AC reports, and reflect a rating given in the report by experts. Examples selected to illustrate achievement are chosen by COVs, ACs, and programs, and are associated with a grant number. These examples highlight in a tangible way, results that were achieved over a period of time. Outcome Goal 4 also includes two quantitative goals. The results for Outcome Goal 5 are quantitative.

This is the first year in which reports were collected and an assessment was completed. Several issues were identified, which will be addressed in future years. In FY 2000, NSF plans to establish parameters to define the acceptability and reliability of the qualitative information it uses. Initial plans call for the establishment of a Standard Deviation or Confidence Limit rule that the Foundation will use to define the quality of the information it uses to ensure uniform quality of information. NSF will use the confidence limit to identify non-substantive information, and information falling outside the confidence limit will be excluded from use.

Data Sources and Limitations for Outcome Goals Using Alternative Format - Table 3

OUTCOME GOAL	DATA SOURCE	LIMITATIONS
1.a **1.b** **2** **3** **4.a**	Independent assessments including COV reports and AC reports using alternative format; program reports; press releases; scientific publications, internal data systems; independently maintained databases.	Non-quantitative information requires judgement of experts; basis for judgement by experts not always evident; substance and timing of outcomes from research and education activities are unpredictable; some local databases not under central quality control; long-term data needed to assess impact of outcomes; potential for self-reporting bias; process to collect and aggregate data needs improvement.
4.b Over 80% of schools participating in a systemic initiative program will 1) implement a standards-based curriculum in science and mathematics; 2) further professional development of the instructional workforce; and 3) improve student achievement on a selected battery of tests, after three years of NSF support.	Internal and external data systems	Data is based on two academic years: 1998 and 1999 (Sept.-June). Respondents understand the definitions, concepts, and timeframes that have been established to govern responses to items concerning curriculum and professional development. Comment fields have been added to data collections systems. Working with districts to facilitate more effective data reproting and utilization. Third party evaluations and research studies being conducted to enhance assessment and interpretation of quantitative results and to address issues of attribution.
4.c Through systemic initiatives and related teacher enhancement programs, NSF will provide intensive professional development experiences for at least 65,000 precollege teachers.	Internal and external data systems	See above.
5.a Timely and relevant **5.b** information	Internal data base (timeliness data); External data base (relevance data)	There may be trade-offs between timeliness -- the speed with which data are released -- and data quality. Increases in timeliness should not be achieved at the expense of decreases in data quality.

Data for Investment Process Goals

These goals are relevant to the means and strategies used by NSF to support the outcome goals and the processes by which NSF shapes its portfolio of awards. In FY 2000, NSF plans to establish parameters to define the acceptability and reliability of the data it uses. Initial plans call for the establishment of a Standard Deviation or Confidence Limit rule that the Foundation will use to define the quality of the data it uses to ensure uniform quality of data. NSF will use the confidence limit to identify non-substantive data, and data falling outside a certain confidence limit will be excluded from use.

Data Sources and Limitations for Investment Process Goals
Table 4

INVESTMENT GOALS	DATA SOURCE	DATA LIMITATIONS
6 Use of Merit Review	Internal data systems	None
7 Implementation of Merit Review Criteria	Program annual reports; COV reports; AC reports using alternative format	Information is subject to review for reliability and accuracy. Implementation more successful for some programs than others; adequate data not always available.
8 Customer Service - Time to prepare proposals	Internal data systems	None
9 Customer Service - Time to decision	Internal data systems	None
10 Award duration	Internal data systems	None
11 Maintaining Openness in the System	Internal data systems	Possible to incorrectly identify a PI as "new" - needs to be monitored
12 Identifying Emerging Opportunities	Internal systems	None
13 Encouraging Integration of Research and Education	Internal systems and public documents	None

Data Sources and Limitations for Investment Process Goals
Table 4 *(continued)*

INVESTMENT GOALS	DATA SOURCE	DATA LIMITATIONS
14 Encouraging attention to diversity in all aspects of NSF programming	Internal systems and public documents	None
15.a Construction and upgrade: within 110% of annual expenditure plan estimates	Internal data systems containing information collected from external sources	New reporting system developed and implemented in FY 1999; facilities managers still gaining experience in collecting and reporting this information.
15.b Construction and upgrade: annual schedule within 110% of estimates	Internal data systems containing information collected from external sources	New reporting system developed and implemented in FY 1999; facilities managers still gaining experience in collecting and reporting this information.
15.c Construction and upgrade: total cost within 110% of estimates	Internal data systems containing information collected from external sources	No construction and upgrade projects completed in FY 1999.
15.d Operations: keep operating time lost to less than 10% of total scheduled operating time	Internal data systems containing information collected from external sources	New reporting system developed and implemented in FY 1999; facilities managers still gaining experience in collecting and reporting this information.

Data for Management Goals

Central data systems as well as internal databases are maintained to collect, verify and validate data pertaining to the management goals. These goals are relevant to the use of new and emerging technologies, training of NSF staff and implementation of management reforms to improve service to NSF's customers.

Data Sources and Limitations for Management Goals
Table 5

MANAGEMENT GOAL	DATA SOURCE	LIMITATIONS
16 New and emerging technologies-electronic proposal processing using FastLane	Central data systems	No serious issues identified
17 Staff diversity	Internal data bases with input by staff applicants	Only 52% of applicatnts provided survey data
18 Capability in use of information technology staff orientation to FastLane	Central data systems	Early issues regarding availability of training data were corrected
19 Implementation of management reforms-Year 2000	Information provided by external contractor	No serious issues identified
20 Implementation of management reforms -- Project Reporting System	Central data systems	Paper copies of reports not captured electronically are not counted

Data Verification and Validation Activities

During FY 1999, NSF staff implemented a Data Quality Project for the quantitative Investment and Management goals. The objectives of the project are:

1. Evaluate the quality of the data in the central databases.

2. Ensure the paper documents and the NSF central databases are synchronized.

3. Identify inconsistencies so that methods for correcting the cause of the inconsistencies can be developed.

4. Ascertain the causes of the data quality problems and develop systematic methods for correction.

5. Develop a comprehensive data dictionary.

6. Promulgate data quality policies and procedures NSF-wide.

This project is currently underway with the first priority placed on the central data systems used to support the performance plan.

In addition, NSF staff implemented new standardized guidelines and reporting procedures for collecting data for the qualitative Outcome goals. The committee of visitor guidelines was revised in FY 1999 to incorporate the GPRA related reporting requirements. Standardized reporting templates were developed for the committee of visitors (COVs) to address the performance of programs in a systematic way to allow for aggregating information across NSF. COV's address a common set of questions for all programs reviewed in a fiscal year. Standardized reporting guidelines were also developed for advisory committees, to allow for a systematic aggregation of information. The results of using the new procedures have identified areas for improvement, which will be incorporated into the FY 2000 reporting guidelines. Many of the results learned while conducting these assessments have been used in revising the FY 2000 performance goals, and the revised strategic plan.

ANALYSIS OF TAX EXPENDITURES

NSF is unaffected.

WAIVERS OF ADMINISTRATIVE REQUIREMENTS

None to report.

APPENDIX: ADDITIONAL EXAMPLES ILLUSTRATING OUTCOMES OF NSF INVESTMENTS

Outcomes relevant to: Discoveries at and across the frontier of science and engineering

- **Robotics:** NSF awards have enabled fundamental new discoveries while promoting collaboration across traditional disciplines. Developments in high performance computing applied to use of robotics in surgery, impacts the simulation, planning and execution of surgery. Use of virtual reality techniques and robotic mechanisms improve the ability of surgeons to perform small-scale micromanipulation tasks.

- **Testing Astronomy's Theories:** Computational methods lead to new discoveries. Of special note was a simulation of the collision of two black holes, important for understanding Einstein's theory of general relativity and how gravitational waves behave.

- **Polar Research:**

  - An international drilling project into the sea floor at Cape Roberts, Antarctica provided evidence of previously unknown large volcanic eruptions in the Ross Sea, and yielded a large number of new species of microfossils, providing important information about how Antarctica evolved into the large stable ice mass we know today. One drilling project drilled 625 meters into the sea floor and recovered core for 95% of the hole, finding many cycles of glacial advance and retreat between about 20 and 35 million years ago.

  - Researchers discovered that during this decade tundra soils have become a source of greenhouse emissions, especially during winter, rather than serving as a depository for greenhouse gases.

- **Understanding the Human Brain:** Scientists attempting to understand the human brain have developed computer models called neural networks, which attempt to simulate the computational power of the nervous system. For every human action –vision, memory, or language- the brain enlists dynamic interacting populations of nerve cells to perform the task. New approaches use a nonlinear neural network combined with computer simulations that mimic the way humans solve problems, not like a digital computer, but by memorizing facts, simplifying, and estimating answers. Progress in these areas has contributed to the design of "smart" machines and other forms of artificial intelligence.

- **Life in Extreme Environments:** Recent discoveries have revealed bacteria living in corroded and leaking tanks containing highly radioactive waste at the Department of Energy Savannah River Site. It was previously assumed that microbial growth was not possible in such an environment of high radioactivity, heat, and alkaline pH. In future work, the investigators propose to culture, identify, and investigate properties of the microbes discovered. This discovery and study has immediate and substantial significance for the safe, long-term storage of radioactive wastes, and may yield important insight into fundamental mechanisms that allow organisms to adapt to extreme environments.

- **Advances in Nanoscience and Engineering:** A new type of atomic force microscope recently developed will enable direct writing on surfaces at nanometer scale resolution – more than 1 billion times smaller than an inch. This method promises to be a tool for nanoelectronics, molecular electronics, and biological applications. In nanoscience and engineering research, nanometer-sized metallic dots linked by conducting organic molecules have been synthesized toward the path of molecular electronics. Nanomagnets in large arrays and nanocapacitors have been fabricated to dramatically improve information storage systems. Nano-scale magnetic probes are also being developed to measure properties of particles important for device technology and techniques for DNA sequencing.

  A young investigator in collaboration with industry and European scientists is making important progress in understanding the fundamental interactions at the nanoscale level between nanopaticle fillers and molecular chains use in making plastics. Understanding these nano-composites and how they work is important for producing new high-strength, low-cost materials, which are likely to find use in applications such as automotive parts, refrigerator liners, business, medical, and consumer equipment housings; recreational vehicles, appliances, pipes and fittings for building and construction industry.

- **Molecular Motors:** NSF supported researchers have developed models of a remarkable variety of molecular motors, the microscopic engines that drive most intracellular motions. Using mathematical and computational models and incorporating experimental data from many laboratories, they have been able to predict motor behaviors at a level that can distinguish between competing theories of how the underlying biological mechanisms work. The predictions in turn have been the impulse for further experiments by others – an example of the interplay between theory, computation, and experiment. The project provides web-accessible data, simulations, and visualizations that are easy for biologists to access and compare to ongoing experiments.

- **Global Change Studies of Glacial Rebound :** Projects using the Global Positioning System to measure vertical crust motion in Antarctica hold the promise of being key to calculating ice mass changes over the past several thousand years. Two competing approaches to the measurement use high tech methods to resolve this difficult but scientifically important problem – How much ice has the Antarctic ice sheet system lost since the last glacial maximum? Initial results are promising, but will require several years to complete a set of measurements to compare with predictions.

- **A High Risk Collaboration** linking academic engineering research with industry investigated a novel method for reducing volatile organic compound emissions in green sand metal castings. The result is successfully being demonstrated at the production level. The process reclaims much of the sand used in the metal casting process, which is a major waste-stream expense and it reduces undesired emissions.

Outcomes Relevant to Connections Between Discoveries and their use in Service to Society

- **From University Lab to Industry Practice:** A university engineer approached by industry to help improve manufacturing quality and reduce time to market has developed an open platform for machine tool control using standard software and hardware. NSF support through a series of awards led to more flexible and open controllers for machine tools; development of the first open architecture machine tools; and development of sensors, controllers, and other tools. These results have been picked up by government labs conducting research in these areas and may stand to benefit from these new tools. These tools allow for faster production, more flexibility, and more opportunity for on-machine inspection and quality control.

- **Innovative Bioengineering Advances:** An NSF supported bioengineer has been recognized by the National Academy of Engineering, the National Academy of Sciences, and the Institute of Medicine, for his accomplishments in the area of bioengineering based on his work on copolymers as matrices for the growth of tissues. This work has led to technology that has spawned an entire field of study and has developed into an industry aimed at cultivating human skin for diabetic skin ulcerations. The Food and Drug Administration has approved the use of the human skin produced through this technique. In yet another area, the same researcher has developed methods to use polymers to deliver drugs, for use in new treatments for some forms of brain cancer. The plastic coated drug is implanted as a small wafer at the time of surgery, and slowly releases a highly toxic drug directly to the tumor site.

- **Plant Genome Research:** In it's ninth year, NSF, the Department of Energy, and the US Department of Agriculture along with international collaborators, are nearing the completion of a project aimed at the first complete genome sequence of a plant. Using Arabidopsis as a model organism for studies of the biology of plants, knowledge generated from its genome sequence is readily applicable to all other plants. With about 80% of the genome sequence completed, the study has already contributed to new discoveries and potential applications to plant-based industries.

- **Knowledge and Distributed Intelligence:** NSF supported research groups have created a Web-based toolkit and research network that links collection databases distributed across 6 museums. Expected to expand to 40 institutions, this powerful database architecture allows investigators to tap millions of records of natural history specimens.

- **Increasing Profits:** NSF supported researchers have studied steel finishing lines owned by 21 American companies and three in Japan, to identify specific combinations of human resource practices associated with employee productivity and product quality. They have found quantitative evidence that one specific combination of quality management practices and participatory human resource management practices boosts these outcomes by between 7.5% and 13%. Only 10% of U.S. steel finishing lines use the high-performance system, although it is responsible for about a $1.5 million in monthly profit in the firms that use it.

- **Communicating Research Results:** NSF funding supported the design, implementation, and incorporation of innovative tools for the electronic communication of research results. The electronic archives are now available to the entire physics and mathematics fields and to sectors of the biology and economics communities. The archive is an enormously successful endeavor that has speeded technical developments in many areas of research. It offers an electronic publishing platform for unrefereed publications that supplements the normal peer-reviewed publications. In August 1999 alone, there were nearly 600,000 connections to the archive alone.

- **Understanding Natural Environmental Processes:**

  - **Climate Dynamics:** NSF support for research in geography and regional science has produced a number of related advances in the understanding of natural environmental processes. For example, climate change frequently has not been gradual; rather, shifts from glacial to post-glacial environments apparently have taken only decades, not centuries as previously thought. Other evidence suggests that droughts as extensive as the Dust Bowl in the 1930s are more common than previously believed. Researchers have discovered connections between forest-fire occurrence in Argentina and El Nino-related atmospheric dynamics. Studies of historical hurricane landfall probabilities along the Gulf Coast have generated enormous media attention.

- **Global Change:** Research on policies dealing with global change is expanding, with obvious prospective benefits for abating the social costs of dealing with global warming. Recent results on the efficiency of alternative forms of emissions abatement are making contributions to long-term policy, as well as a better understanding of how rich and poor countries differ in their approach to handling environmental problems.

- **Advancing Information Technology:**

  - NSF supported projects rapidly utilized in other sectors and demonstrating value to society include activities involving the early development of WWW search tools: Webcrawler (which is now Excite), Lycos, Infoseek, and the Library of Congress "Thomas" system for searching.

- **Better Materials:** NSF-supported researchers have gained a fundamental understanding of a new class of ultra-high-strength cement based materials that have a fracture strength 50 times that of conventional concrete. Using NSF findings, a foreign industry built the body of a new solar car which received awards for its outstanding achievement as an earth-friendly, low-energy material. In a rally held in Japan, the low weight car averaged a speed of nearly 28 miles per hour over a distance of more than 300 miles. Italian industry is commercializing the material for use as cladding panels.

- **Students Doing Hands-on Research:** An NSF supported project allows students to view on-line actual astronomical images and to extract information from them in the same way professional astronomers do. Teaching thousands of students the basic principles of astronomy, it has enabled students to take part in the discovery of a supernova and an asteroid.

- **Take Another Look** - an exhibit disseminated to nine sites that has reached 1.5 million visitors. Its purpose is to develop powers of observation in children and adults, with the target audience being parents, teachers, and children ages 2-10. One interesting finding demonstrated that parents were three times more likely to explain science to boys than to girls, while families were using interactive exhibits. The findings have been widely disseminated through articles and presentations to encourage further development.

Examples of Outcomes Relevant to A Diverse, Globally-oriented Workforce of Scientists and Engineers

- Collaborative teacher preparation programs enrolled nearly 74,000 undergraduates and post-baccalaureate students (58% females; 30% underrepresented groups) in courses supported by the NSF program.

- More than 60,000 teachers were part of local school reform projects from 1995 to 1999 that NSF supported. Seventeen percent were African American or Hispanic.

- In an NSF-supported educational program, institutions conferred more than 20,000 degrees to underrepresented minorities in science and engineering in 1998, representing sustained progress toward the program goal of doubling minority baccalaureate degree recipients in the program.

- **Careers in Marine Science:** An NSF funded project is a national effort to provide research experience and mentoring for minority students in ocean sciences. The participant group has been diverse, consisting of 70 percent African-Americans, 21 percent Hispanic-Americans, 3 percent Pacific Islanders, and 6 percent Native Americans. Students from more than 100 different institutions have participated in the past ten years, with 31 different colleges and universities in the 1999 program alone.

- **NSF-supported Research Experiences for Undergraduates:** NSF invests in many efforts to bring young students closer to actual research experiences. One of the largest efforts in the Foundation for one field of science involves support for 55 sites in 36 states, at which about 600 students are supported each summer. Typically half the participants are female, and over sixteen percent are from underrepresented groups. In a similar program for another field of science, over 1,200 undergraduates receive hands-on experience each year. Some of these efforts provide unique international experiences for students. Many of the participants are recognized as co-authors on papers resulting from their involvement. Such programs introduce students at an early stage in their career to important approaches and concepts outside their traditional experiences.

- **International Partnerships:**

  - NSF funds are used to support many international collaborations. One involving three European partners is trying to repress zebra mussels, which pose a huge environmental threat to the Great Lakes and possibly the Chesapeake Bay. These tiny mussels, which clog valves on ships, power plants, and water supplies, originated in Belarus, Ukraine, and Russia, where the research projects are collecting data on their habitats and life cycle. This information is helping to develop methods of controlling these extremely costly infestations. Without a coordinated international approach, this progress would not be possible.

  - At an NSF supported international research site for undergraduates in Tanzania, U.S. undergraduates learn fundamentals of biological and geological processes related to tropical lakes. Their research and the associated education relates to global change processes, including early warning signs of freshwater ecological change.

Examples of Outcomes Relevant to Improved Achievement in Mathematics and Science Skills Needed by all Americans

- **Instructional Materials Developed with NSF Support:** Of 12 middle school mathematics textbooks subjected to rigorous analysis by the American Association for the Advancement of Science, only the 4 supported by NSF received high ratings.

- **Gains in K-12 Student Performance Reported:** In Puerto Rico national and international mathematics and science assessments administered in grades 4, 8, and 11 show overall that students performance in mathematics and science was significantly higher at those high schools with students exposed to the NSF supported activities, compared to the performance of high schools whose students had not had such exposure.

- The 1998 Connecticut Mastery Test results confirmed continuing improvement in student mathematics performance from 1993 to 1998 in that state: in grade 4, the percentage of students meeting performance goals improved from 53% to 61%; grade 6 student performance increased from 44% meeting goals to 53%; and grade 8 growth moved from 46% meeting goals to 56%.

- Detroit students showed significant gains in the percentage of students performing at the highest level in science and mathematics on the Michigan Educational Assessment Program between 1994 and 1998: (1) grade 5 science – an increase from 18% to 33%; (2) grade 7 mathematics – an increase from 16% to 33%; and (3) grade 4 mathematics – an increase from 33% to 65%.

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