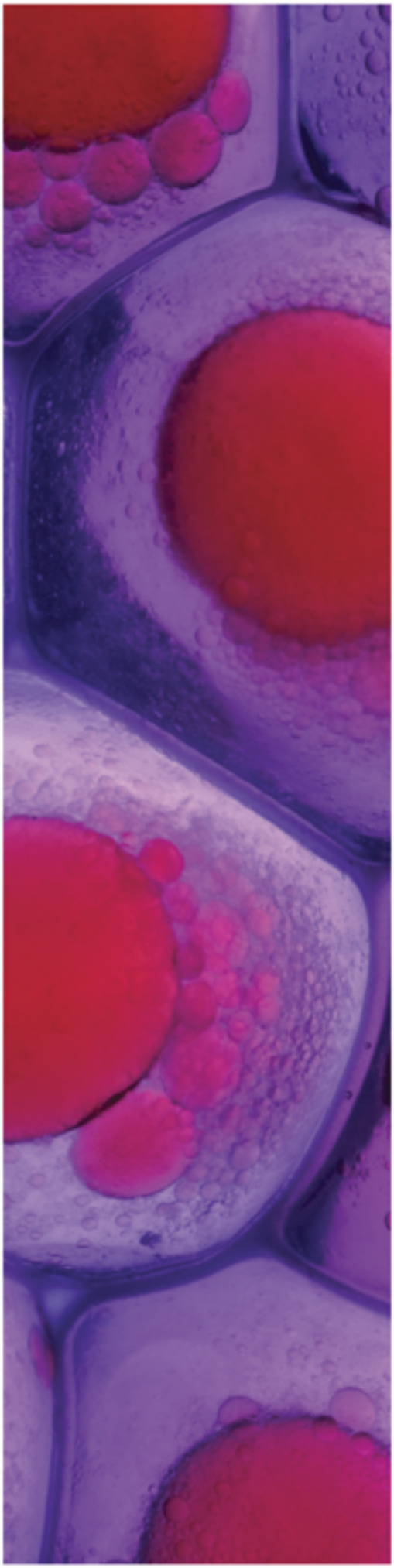

GPRA PERFORMANCE REPORT FY 2000

NATIONAL SCIENCE FOUNDATION

MARCH 2001

NSF Creation and Mission

The National Science Foundation 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 NSF statutory mission was established by the Act of 1950:

To promote the progress of science; to advance the national health, prosperity, and welfare; and for other purposes.

The Act authorizes and directs 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.

Enabling the Nation's future through discovery, learning and innovation.

Realizing the promise of the 21st century depends in large measure on today's investments in science, engineering and mathematics research and education.

NSF investments – in people, in their ideas, and in the tools they use – will catalyze the strong progress in science and engineering needed to secure the Nation's future.

NSF is a Source of Human Capital

for People who win Nobel Prizes-
And who become Teachers,
And CEOs, and Politicians.

We foster and encourage creative thinking; we select for excellence; and we fund the best and the brightest based on merit. We all benefit-and the American people most of all.

Rita Colwell, Director, NSF

Message from the Director

I am pleased to present the National Science Foundation's Annual Program Performance Report for fiscal year 2000, as required by the Government Performance and Results Act of 1993 (GPRA). Here you will learn about NSF's progress in meeting a broad range of challenging goals that aim to improve our ability to invest in the nation's future.

The year 2000 marked NSF's 50th Anniversary. During this half century, knowledge about the world has exploded and the pace of scientific discovery and technological innovation has accelerated unabatedly. By spurring innovation, advances in science and engineering knowledge lay the foundation for new jobs and fuel economic growth, raising U.S. living standards and improving the quality of life.

Through its public investments in fundamental research and education, the Foundation has played an important role in keeping the U.S. at the forefront of these developments. They have brought us advances in biomedicine, new modes of communication, and led to improvements in public safety, agriculture, and industry. They have enabled the U.S. to sustain a half-century of world leadership in science, engineering and technology.

Just consider the following achievements highlighted in the report:

- *New evidence of life in extreme environments.*
- *The Boomerang project, which brought new insights into the "geometry" of the universe.*
- *New nanowires: self assembling structures that hold the potential to increase the capacity of computer memory chips by a factor of 200.*
- *Substantial increases in student achievement – and a narrowing of the gap between minority and majority students – through investments in educational systemic reform.*

It is also noteworthy that of the 11 Nobel laureates announced in 2000, six have been supported by NSF.

NSF's mission is to strengthen the nation's capabilities across the entire spectrum of research and education in the sciences, engineering, and mathematics. Each year the Foundation invests in the creative people, the innovative ideas, and the cutting-edge technologies that will have the highest returns in advancing discovery at the frontiers of knowledge. It works to promote science, engineering, and mathematics learning – from pre-school through post-doctoral – to prepare the next generation of scientific talent and foster a U.S. workforce that is second to none in the world.

Because the results of fundamental research are often realized only years later as they are transformed into the products and social benefits that improve our lives, NSF faces unique challenges in measuring

and evaluating performance. NSF has developed an evaluation process that reflects these challenges. Each year, NSF uses the GPRA review process as an opportunity to improve and refine the way it measures and rates its success.

In conducting its FY 2000 performance review, NSF raised the bar on performance. We increased the stringency of evaluation criteria, set goals that were significantly beyond past performance, added new categories of achievement, and submitted NSF activities to unprecedented levels of internal and external review. In addition to Foundation staff, about 400 external evaluators participated in the performance assessment, and generated 64 reports covering 78 of the NSF's 200 programs.

Using these high standards, NSF met two-thirds of its 28 revised goals. The agency met six of its eight goals relating directly to the results of research and education, and outside evaluators noted progress toward realizing the other two. Among the management and investment process goals that were not met, NSF achieved substantial improvements in many areas. Examples are increased capacity to process proposals electronically, and an increase in the percent of awards involving new investigators – a key measure of the "openness of NSF's system."

In other areas, more stringent ratings produced results that were actually lower than in FY 1999, despite the fact that outside evaluators cited progress in those areas. One goal not met in FY 2000 – NSF's successful implementation of the new merit review criteria – is the result of the establishment of two new merit review criteria in FY 1998. For this performance report, the baseline for the agency's evaluation (a period of three years) includes one fiscal year of merit review that did not incorporate the new criteria.

NSF's FY 2000 Report describes in detail the criteria NSF uses to assure the credibility of the data used to verify and validate progress in accomplishing its goals. This year, NSF submitted its data and methods to independent, external review by PricewaterhouseCoopers LLP.

It is our aim at NSF to adhere to the highest standards of management efficiency and integrity, and to produce outcomes of substantial benefit to the nation. I am therefore pleased to report that the data measuring NSF's performance that are contained in this report are complete and reliable.

Sincerely,

Rita R. Colwell
Director

Executive Summary

This report, made pursuant to the Government Performance and Results Act (1993), covers activities of the National Science Foundation during Fiscal Year 2000. It is substantially more comprehensive than its predecessor, and records an unprecedented level of effort and achievement.

In conducting the FY 2000 assessment, NSF undertook the most rigorous and challenging performance review in its history. Several goals and indicators were added or revised, and evaluation criteria were made much more stringent.

Previously used ratings such as "partially successful" or "minimally effective" were eliminated; all outcomes were judged either "successful" or "not successful." As a result, some of NSF's performance scores were actually lower than in FY 1999, despite the fact that outside evaluators cited progress in those particular areas since 1999.

In addition to Foundation staff, about 400 external evaluators participated in the performance assessment, and generated 64 reports covering 78 of the NSF's 200 programs. NSF engaged an independent outside examiner, PricewaterhouseCoopers LLP, to verify data compilations.

The Foundation aimed extremely high. For example, NSF set itself the goal of processing 70 percent of proposals within six months of submission. That would have been unmatched in the Foundation's history, and would far exceed the norm at comparable granting agencies. In fact, during FY 2000 well over half of all NSF proposals were fully processed within six months and 71 percent were fully processed within seven months. By most measures, that would be considered extraordinary; yet it was not successful by NSF's high standards.

Similarly, NSF attempted to develop the technological capability that would permit the electronic review and processing of tens of thousands of competitive proposals each year - making it possible to do so without generating any paperwork within the Foundation. No other research and education funding organization in government has attempted such a feat. NSF did encounter significant technological challenges in trying to realize this goal, but robust progress was made and the agency will initiate pilot projects to demonstrate its electronic review process capability during FY 2001.

Other goals in which NSF was rated "not successful" simply may not be achievable within a short time, such as "improved achievement in mathematics and science skills needed by all Americans". Performance assessment activities in FY 2000 clearly demonstrated that a goal of reaching *all* Americans was unrealistic. Consequently, NSF will revise its performance indicators in future years to focus on related aspects more directly within the agency's responsibility and control.

However, even with new and revised goals and more exacting definitions of success, the Foundation met two-thirds of its 28 goals, which are divided into three broad areas: outcome goals, management goals, and investment process goals.

Outcomes

Outcome goals concern the practical, concrete results of NSF grants and programs, as opposed to the procedures and methods whereby the Foundation carries out its work.

NSF achieved 75 percent (6 out of 8) of its goals in the Outcomes category, notably including:

- production of "discoveries at and across the frontiers of science and engineering";
- rapid and widespread connections between those discoveries and society as a whole;
- ensuring that more than 80 percent of schools participating in education-improvement projects called "systemic initiatives" make substantial progress;
- providing intensive professional development programs for at least 65,000 teachers in grades K-12;
- prompt compilation and electronic dissemination of essential national data sets; and
- development of ways to determine and assure the quality of survey materials.

Two ambitious goals were rated as "not fully successful" (that is, not successful) by reviewers. One was the objective of ensuring that NSF grants contributed to improved scores in "mathematics and science skills needed by all Americans," as judged by independent external evaluators.

The other was the attempt to produce a "diverse, globally oriented workforce of scientists and engineers." Both outcomes are extremely difficult to achieve, and neither is completely within the Foundation's responsibility and control. In NSF's pursuit of both goals, however, evaluators noted progress since FY 1999.

Management

Management performance goals concern the effectiveness and efficiency of the way NSF handles its workload. For FY 2000, the Foundation identified 6 specific management goals, and achieved 5 of them (83 percent).

Goals that were met included:

- ensuring that at least 60 percent of full proposals are submitted electronically through the computer-based "FastLane" system;

- increasing the total number of science and engineering hires from under-represented groups, as judged against the FY 1997 baseline (NSF achieved a 120 percent increase in female hires and a 27 percent increase in minority hires);

- providing FastLane orientation for all NSF staff and insisting on practice in key modules for at least 80 percent of program and support staff;

- completing work on all "Y2K" information-technology problems as planned, on schedule and within budget; and

- ensuring that at least 85 percent of all project reports are submitted electronically through a new, computer-based Project Reporting System.

Only one management performance goal was not met. NSF had set itself the objective of having the technological capability to move competitive proposals submitted electronically through the entire review and award/decline process without generating any paperwork.

While this may have been extremely ambitious, significant progress was made. By the end of FY 2000, the only significant impediment to attaining a full electronic review capability was the development of a secure "electronic signature". This issue will continue to be addressed in FY 2001 when the agency will pilot ten all-electronic review projects.

Investment Process

Investment process goals involve the specific procedures whereby NSF makes grants, funds and manages capital projects, and serves its customers in general.

For FY 2000, NSF identified 15 such goals. One was found to be inapplicable. Of the remaining 14, the Foundation clearly achieved 7, or 50 percent. Those included:

- allocating at least 90 percent of funds to projects reviewed by external peer groups and selected through merit-based competition;

- identifying possible reasons for any customer dissatisfaction with NSF merit review and complaint-management systems;

- improving NSF's overall American Customer Satisfaction Index;

- devising systems that require Principal Investigators to integrate educational components into their research proposals, and verifying the outcome;

- developing methods of requesting and tracking reviewer answers to NSF merit review criterion - "what are the broader impacts of the proposed activity";

- find ways to increase the number of women and under-represented minorities in the pool of applicants for grants; and

- keep costs of construction and upgrades on facilities within 110 percent of estimates.

NSF did not meet 7 of its Investment Process Goals, even though efforts during FY 2000 often produced remarkable, measurable progress toward achieving those goals.

For example, NSF attempted to ensure that 95 percent of program announcements and solicitations would be available at least three months prior to proposal deadlines or target dates. In fact, 89 percent of announcements and solicitations met that standard - up from 75 percent in the preceding year - and 97 percent of program announcements and solicitations were available within 5 days of the three-month goal.

Another important area involves the goal of making at least 30 percent of competitive research grants to new investigators. In determining its performance on this goal, NSF counted only awards made to new Principal Investigators. During FY 2000, 28 percent of awards were made to new Principal Investigators – up from 27 percent in FY 1999. However, more than 33 percent of FY 2000 awards were made to teams of Investigators where at least one Investigator was new – up from 31 percent in FY 1999. So although the goal was not achieved in its strictest interpretation, the results reported clearly demonstrate an increasing "openness in the system" that the agency is committed to maintain.

Finally, NSF has committed to ensure that external merit reviewers take *both* NSF criteria fully into account when evaluating proposals. The two generic criteria are, simply put, scientific importance to the individual field, and broader significance to science and society as a whole. Although evaluators noted considerable improvement in this area, they rated NSF's overall performance as "not fully successful", that is, not successful.

That outcome was not unexpected since the new merit review criteria were implemented only in early FY 1998. In assessing the agency's FY 2000 performance, external evaluators examined proposals considered for funding in FY 1997, FY 1998, FY 1999 and in a few cases, FY 2000. Therefore, only about two thirds of proposals examined actually could have been measured against the new merit review criteria. However, evaluators did note that for those proposals subject to the new review criteria (i.e. those submitted for funding consideration in FY 1998, FY 1999 and FY 2000), NSF staff had been generally successful in employing both criteria in making funding decisions. They also noted that NSF needs to increase its outreach efforts to the research and education community to ensure that proposers and reviewers alike adequately address both criteria in proposals and in the proposal review process.

Realization of this goal is increasingly likely over the next few years as NSF effectively communicates to proposers and reviewers the importance of addressing both criteria in proposals and reviews, and as evaluators examine a full complement of proposals subject to these criteria.

In four other goal areas, NSF did not successfully realize the high standards it set.

In one, NSF had attempted to process 70 percent of proposals within six months of receipt. Although only 54 percent of proposals were processed within that time frame, 71 percent of proposals were processed within seven months. This represents an accomplishment, considering the increasing complexity and multidisciplinarity of proposals and NSF's continuing commitment to external merit review. Nonetheless, the Foundation will take steps to improve its performance in this area in FY 2001 and will again set its sights on processing 70 percent of proposals within six months.

Another goal was to identify the best practices with which NSF staff could explain the merit review process, answer questions, and handle complaints.

During FY 2000, NSF conducted several customer-service surveys in an attempt to understand and improve its performance in these areas. Three concerns identified were: the quality and fairness of proposal review; ease of submitting proposals via FastLane; and trouble finding the right person to contact when questions arise. Models of best practice are still being developed, and staff training is underway.

A third goal involved keeping facilities' construction and upgrades within annual schedules and assuring that total time for completion of each phase did not exceed 110 percent of estimates. This goal is ambitious, although it is one the agency strives to realize. Nonetheless, in many scientific construction projects, unforeseen (and perhaps unforeseeable) delays occur as a consequence of rapidly changing technology and as a result of the fact that many such projects are unique. In those circumstances, it is very difficult to produce exact guidelines or timetables. Even so, of eleven construction and upgrade projects supported by NSF, seven (or 64 percent) of them met the goal.

Finally, NSF had set a goal of holding operating time lost due to unscheduled downtime at NSF-funded facilities to less than 10 percent of total scheduled operating time. Again, that target proved difficult to achieve because of the special problems that crop up in such projects. Nonetheless, of 26 reporting facilities, 22 (85 percent) met the downtime goal, and only four did not.

Based on what was learned from the FY 2000 performance assessment, NSF will pay particular attention to certain areas in FY 2001; these include improving customer service by increasing the percentage of proposals processed within six months and focusing on the effective implementation of the merit review criteria.

Using the experience gained in measuring and assessing performance in FY 2000, the agency will revise its FY 2002 performance indicators to focus more closely on achievements for which it has responsibility and control. The Foundation will continue to set the highest standards for itself and to employ the most stringent criteria for review of its accomplishments.

Performance Reporting Requirements

The Government Performance and Results Act of 1993 requires each Federal agency to report no later than 180 days following the close of each fiscal year to the President and the Congress on it's performance for the previous fiscal year.

Each performance report must set forth performance indicators as established in the performance plan, along with actual performance achieved compared with the performance goals for that fiscal year.

If performance goals are specified in the alternative form, the results shall be described in relation to the specifications, including whether the program failed to meet the criteria of a minimally effective or successful program.

The report for fiscal year 2000 must include actual results for the preceding fiscal year.

According to the OMB Circular No. A-11 (2000) revised draft dated December 22, 2000, each report must include the following elements:

1. A comparison of actual performance with projected levels of performance as set out in the performance goals in the annual performance plan;
2. An explanation, where a performance goal was not achieved, for why the goal was not met;
3. A description of the plans and schedules to meet an unmet goal in the future, or alternatively, the recommended action regarding an unmet goal where it is concluded that it is impractical or unfeasible to achieve the goal;
4. An evaluation of the performance plan for the current fiscal year, taking into account the actual performance achieved in the fiscal year covered by the report;
5. An assessment of the reliability and completeness of the performance data included in the report; and
6. Eventually, actual performance information for at least four fiscal years.

Other features as they apply to the agency:

a. Program evaluations;
b. Information on use of non-Federal parties;
c. Classified appendices not available to the public;
d. Description of the quality of the reported performance information;
e. Budget information;
f. Analysis of tax expenditures; and
g. Waivers of administrative requirements.

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I. AGENCY PROFILE AND GOALS

As the world marked the beginning of a new millennium, the National Science Foundation (NSF) celebrated its 50th year as a leader and steward of the nation's scientific and engineering research and education enterprise. NSF is the only Federal agency dedicated to the support of fundamental non-medical research and education across all science, mathematics, and engineering disciplines and for all levels of education.

The Foundation's responsibility is in contrast to other Federal agencies, which provide specific services or support mission-oriented research objectives related to energy, biomedicine, or space. NSF supports research and education via grants, contracts, and cooperative agreements to about 1,800 colleges, universities, K-12 schools, academic consortia, non-profit organizations, small businesses and other research institutions – public, private, state, local, and Federal – throughout the United States.

In FY 2000, approximately 95% of NSF's $3.9 billion budget supported research and education activities carried out by awardees at their home institutions. These programs and activities directly engaged nearly 184,000 people, including researchers, educators, students, and other professionals. To conduct the administrative work of the agency, NSF employed a scientific and engineering staff of approximately 1250 government employees, more than 120 visiting scientists and engineers, and over 190 contractors. NSF staff administer the merit review and award process: they do not conduct the research nor do they operate the laboratories supported by NSF awards.

THE FOUNDATION ACTS AS A CATALYST – investing federal funds to support the best ideas and the most capable people to pursue new knowledge, discoveries, and innovation. NSF strives to identify future areas of innovation for the potential prosperity of the Nation.

As part of their administrative responsibility, NSF staff processed approximately 240,000 merit-based reviews and made funding decisions on nearly 30,000 competitive proposals submitted by applicants in FY 2000. NSF staff processed about 9,760 new awards and 6,680 continuing awards. New awards were selected by merit review conducted by about 50,000 external reviewers who donate tens of thousands of hours each year to the review of proposals for research and education.

NSF provides national leadership in improving science, mathematics, engineering and technology (SMET) education, and in broadening participation in the SMET enterprise to prepare a diverse, globally oriented workforce. NSF plays a major role in the development of our nation's future scientists and engineers.

Throughout the last fifty years, NSF has worked diligently to identify and enable the best science, mathematics, and engineering research and education possible for the entire country.

These fifty years have been marked by path-breaking advances in science and engineering knowledge that have spurred innovation, fueled economic growth, and led to the highest standard of living in U.S. history. Discoveries at the frontiers of knowledge have transformed agriculture, communications, transportation, and industry for the benefit of the American public. NSF-supported projects have contributed to significant improvements in a broad array of areas – among them education, public safety, national defense, health, and the environment. In this report, NSF shares its enthusiasm for its work, and hope to engage readers in a better understanding of the NSF mission and role in the federal system. NSF's hope is to continue to be a leader in enabling scientific discoveries, developing people, and providing the necessary tools to advance fundamental research and learning in all fields of science, mathematics, engineering, and education over the next fifty years. NSF's purpose is to ensure that future generations will enjoy sustained health, prosperity, and a higher quality of life.

A. ORGANIZATION OF PERFORMANCE GOALS

The Foundation's primary mission is to promote the progress of science by ensuring that the United States maintains leadership in discovery, learning and innovation across science, mathematics, and engineering. NSF carries out its mission by making merit-based awards to support the work of outstanding individuals and groups, in partnership with colleges, universities, and other institutions – public, private, state, local, and Federal – throughout the U.S. NSF awards are the Nation's investment in individuals and organizations who ultimately develop and produce the outcomes of the investment process that NSF manages.

NSF awards provide resources to enable, enhance, and secure the nation's future through discovery, learning and innovation.

To create a high quality balanced portfolio of awards to best serve the Nation, NSF developed the FY 2000 Annual Performance Plan and goals based on *the NSF Strategic Plan, FY 1997-2003*. The NSF FY 2000 Annual Performance Plan is organized into three areas of mutually supportive goals for the agency to pursue. The FY 2000 goal areas are Outcomes, Management, and Investment Process. NSF Strategic Plans and Annual Performance Plans may be found on the NSF web site at http://www.nsf.gov/od/gpra/start.htm.

The Outcome Goals address the Foundation's programmatic investments as they relate to the agency's mission and are intended to cover the full range of activities supported by NSF awards. The Management and Investment Process Goals are important for the success of the Outcome Goals. NSF's Outcome Goals are long-term goals which are difficult to measure annually or directly, and thus are evaluated qualitatively and by looking for progress and trends over many years. To determine progress in achieving the Outcome Goals, NSF aggregates performance across the agency annually and relies upon the qualitative judgement of external experts. All goals and results achieved for FY 2000 are described in detail in Section V of this report.

GOALS FOR OUTCOMES

NSF's five broad Outcome Goals focus on ensuring that the results of NSF's awards for research and education in science, mathematics, and engineering promote the progress of science. A new goal addressing data quality measures for reporting Science Resource Studies (SRS) products was added in FY 2000. Details relevant to the Outcome Goals are presented in Sections IV. and V.A. along with results for FY 2000 and examples of achievements.

1. Discoveries at and across the Frontier of Science and Engineering;
2. Connections between Discoveries and their use in Service to Society;
3. A Diverse, Globally-oriented Workforce of Scientists and Engineers;
4. Improved achievement in Mathematics and Science Skills needed by All Americans; and
5. Timely and Relevant Information on the National and International Science and Engineering Enterprise.

GOALS FOR MANAGEMENT

Management Goals address the efficiency and effectiveness of administrative activities in support of NSF's mission. Two new management goals were added in FY 2000: one addressing electronic proposal processing and one addressing staff diversity. See Section IV and V.B. for a description of the Management Goals and results for FY 2000.

GOALS FOR INVESTMENT PROCESS

Investment Process Goals focus on the means and strategies NSF uses to achieve its Outcome Goals and set performance targets for the quality and integrity of the investment processes employed by NSF to shape its portfolio of awards. Several new goals were added in FY 2000 to address customer service, the integration of research and education, and diversity. See Section IV and V.C. for a description of the Investment Process Goals and results for FY 2000.

B. FOCUS ON OUTCOMES

NSF focuses its goals on long-term outcomes because they ultimately convey the value and demonstrate the impact of what NSF does for the American public. Each year, NSF receives nearly 30,000 proposals for research and education projects. NSF staff make use of the merit review process to select the most promising activities that will lead to the best results or

outcomes in the future. The total amount requested in these proposals exceeds, by many multiples, the annual NSF budget. Given this intense competition, NSF is able to support only one in three new proposals each year.

Each year, NSF annually reviews the collection of results reported by awardees during the year. However, the outcomes of NSF investments are the long-term impacts of awards, rather than the incremental annual progress of individual projects. Outcomes are the results which provide the evidence of NSF's success as an investment agent for the country. NSF believes strong performance in achievement of the Outcome Goals is vital to the nation's future economic strength, security, and quality of life.

C. How NSF is Structured

The Foundation is comprised of the National Science Board (NSB) and a Director who also serves as an *ex officio* NSB member. The NSB is composed of 24 part-time members who are appointed by the President and confirmed by the U. S. Senate. Members are selected on the basis of their eminence to represent all areas of science, mathematics, engineering and education, including basic, medical, or social sciences, engineering, agriculture, education, research management, industry, or public affairs. Members are expected to represent the views of the scientific and engineering communities nationwide.

NSF works to support the best and brightest undergraduate and graduate students in science, mathematics, and engineering. NSF provides the most promising students from diverse backgrounds with opportunities that will give them a global education and enable them to become our future leaders and citizens.

Terms of service on the NSB are six years, with no member serving more than two consecutive terms. The National Science Board has dual responsibilities as national science policy advisor to the President and the Congress and as the governing body for NSF.

Other senior officials include a Deputy Director who is appointed by the President with the advice and consent of the U.S. Senate, seven Assistant Directors and two Office Directors. Proposals and awards are managed by nine programmatic organizations comprised of seven disciplinary directorates (Biological Sciences; Computer and Information Science and Engineering; Engineering; Geosciences; Mathematical and Physical Sciences; Social, Behavioral and Economic Sciences; and Education and Human Resources), and two offices: the Office of Polar Programs, and the Office of Integrative Activities. The more than 1250 NSF staff members work to coordinate NSF's investments with those of other organizations, agencies and countries to provide synergy and integration to the science and engineering enterprise of the Nation.

NSF carries out its responsibility to the nation by supporting a broad range of activities. A few are described below:

- NSF has major programs for research and education in information technology, computing, and communications.
- NSF has a unique geographic responsibility for the north and south polar regions - and plays a central role in environmental issues related to global climate studies and extreme environment studies.
- NSF supports fundamental research in the earth, atmospheric, and ocean sciences to advance our understanding of the behavior of the Earth's atmosphere and its interactions with the sun.
- NSF focuses on strengthening the nation's engineering science base in the areas of engineering systems, devices and materials, and associated engineering processes and methodologies.
- NSF supports research to advance the understanding of the underlying principles and mechanisms governing life. NSF leads in supporting plant research from detailed genetic characterization and sequencing work to biochemistry, cell biology, plant development, and ecology.
- NSF provides leadership in supporting researching on learning and education, improving science, mathematics, engineering and technology (SMET) education, and in broadening participation in the SMET enterprise at every educational level.
- NSF supports a diverse portfolio of research and education in mathematics, astronomy, physics, chemistry and materials research to deepen our understanding of the physical universe and to use that understanding in service to society through training the future workforce.
- NSF supports research to advance the understanding of the behavior of human beings and the economic, political, and social consequences of their behavior; one of the highest priorities is to improve the quality of life in the U.S. by enriching understanding of the knowledge base about people.
- NSF promotes partnerships between U.S. and foreign researchers and enhances access to critical research conducted outside the US.
- NSF provides data and analysis on the science and engineering enterprise in the U.S. from an international perspective for policy-makers, researchers, and others. NSF works with other Federal agencies, academic institutions, industry, foreign, and multi-national organizations to identify and meet key data needs for policy decision making. Key products include Congressionally-mandated reports, statistical reports from national surveys, special topic reports, and public use data bases.

NSF investments provide state-of-the art TOOLS for research and education, such as instrumentation, equipment, and multi-user facilities like accelerators, telescopes, research vessels and aircraft, and earthquake simulators.

II. EXAMPLES OF ACHIEVEMENTS REPORTED IN FY 2000

NSF is proud to share just a few of the many highlights of the research and education results reported by awardees in FY 2000. These examples were selected as some of the most exciting discoveries and results reported this past year. They reflect the broad range of achievements important to NSF's mission. Each result was obtained in part or entirely through NSF support. Highlights of research and education projects reported by NSF's Office of Legislative and Public Affairs (OLPA) are presented first, followed by examples reported by awardees and recognized by external committees as noteworthy achievements in FY 2000. Additional examples relevant to each of NSF's outcome goals are presented in Section V.A, *"Outcome Goals and Results for FY 2000*," and also in Section XIV, "*Appendix of Additional Examples Illustrating Outcomes of NSF Investments*."

FY 2000 RESEARCH AND EDUCATION HIGHLIGHTS – EXAMPLES REPORTED BY OLPA (BY TITLE)

Below are titles for NSF supported research discoveries and results that were reported as highlights by NSF's Office of Legislative and Public Affairs (OLPA). To look at the stories associated with these titles, and to look at more examples, search the NSF highlights reported at http://www.nsf.gov/home/news.html. This web site will present more detail, and is a source of additional stories of recent newsworthy highlights and exciting findings.

- Astronomers Find Evidence for the First Planet Seen Orbiting a Pair of Stars
- Scientists Report First Complete DNA Sequence of Plant Chromosomes
- Earthquake Network Intended to Help Save Lives and Money
- Bacteria May Thrive in Antarctic Lake
- Report Shows Students Improving in Math and Science Preparation
- Global Seismographic Network Establishes Internet Connection to Remote Africa
- Solar "Heartbeat" Discovered
- Astronomers Sight an Asteroid's Moon
- Exploring the Far Frontiers of Sea and Space
- Membrane Protein Research Yields New Insights into Inner Workings of the Cell
- New England Experienced "Ice Age" El Niño
- Human-Computer Interaction Gets a Helping Hand, Eye, and Voice
- Researchers Discover Evidence of Microscopic Life at the South Pole

Three examples of NSF Highlights from the OLPA Exciting Findings are:

REPORTED JANUARY 14, 2000

- **SCIENTISTS REPORT FIRST COMPLETE DNA SEQUENCE OF PLANT CHROMOSOMES**

  Scientists involved in an international effort to sequence the entire genome of Arabidopsis thaliana reported the first complete DNA sequence of a plant chromosome in the December 16, 1999, issue of the journal *Nature*. The results provide new information about chromosome structure, evolution, intracellular signaling, and disease resistance in plants. The research conducted by U.S. participants was funded in large part by the National Science Foundation, as well as the U.S. Department of Agriculture and U.S. Department of Energy.

REPORTED JUNE 22, 2000

- **NEW ENGLAND EXPERIENCED "ICE-AGE" EL NIÑO**

  The New England region underwent El Niño-like climate changes during the Ice Age, NSF-supported researchers have found. Scientists define El Niño as a disruption of the ocean-atmosphere system in the tropical Pacific, which has important consequences for weather around the globe. The team's findings show a strong three-to-five-year cycle of El Niño activity during the latter part of the last Ice Age–the same frequency with which El Niño occurs today.

REPORTED FEBRUARY 7, 2000

- **TWELVE PIONEERING RESEARCHERS RECEIVE 1999 NATIONAL MEDAL OF SCIENCE**

  On January 31, 2000, President Clinton named 12 of the nation's most respected researchers, three of them Nobel Prize winners, to receive the 1999 National Medal of Science. Honoring the discoveries and lifetime achievements of the nation's top scientists, the Medal of Science recipients named by the president represent a widely diverse group that: created wholly new scientific fields, such as conservation biology and speech sciences; led to discoveries that determined why the ozone "hole" exists; and legitimized theories about technological progress on economic growth, among others.

FY 2000 RESEARCH AND EDUCATION HIGHLIGHTS
EXAMPLES CITED BY EXTERNAL EVALUATORS

Examples of results cited by committees of external evaluators in the performance assessment process are presented below. These examples are but a few of the many that were recognized as contributing to the successful performance of NSF in FY 2000. Examples are presented here to give the reader a more tangible feeling for the value and impact of NSF investments. Many of these examples illustrate the broader impacts of NSF-supported research and education activities on the Nation and its citizens. Each example has been recognized as contributing toward the achievement of one or more of NSF's Outcome Goals. Additional examples illustrating outcome achievements appear in Section V.A.. "*Findings from Program Assessments*

and Evaluations: Outcome Goals and Results for FY 2000," and also in Section XIV, as an Appendix to this report.

- **NANOSCIENCE AND ENGINEERING - NANOMOTORS** The merger of molecular biology and nano-fabrication in engineering research has led to the assembly of a spinning molecular motor through the nanoscale assembly of protein flagella onto an array of nickel posts. The researchers grafted these bacterial motors to an ordered array of nano-scale metal posts and measured the revolutions per second, horsepower, and motor efficiency. This is a critical first step in integrating biological-mechanical components with deliberately patterned inorganic nanostructures that will produce entirely new classes of more powerful nanostructured devices. Ultimately, the researchers envision these nanomotors powering nanofactories that synthesize and deliver drugs directly to the tissues that need them, reducing toxicity to other tissues and increasing the effectiveness of drug therapies.

- **A FLAT UNIVERSE** A spectacular burst of new information about the Early Universe – Cosmic Microwave Background, or CMB – is transforming the field of cosmology. The CMB radiation is considered to be a residue from the Big Bang origin of our universe some 12-15 billion years ago. Using balloon-borne microwave detectors as a telescope, the Boomerang project is an experiment that maps the CMB radiation using highly sensitive arrays of microwave detectors. The balloon-borne telescope circumnavigates the Antarctic continent suspended at an altitude of 120,000 feet (36,576 meters). The high-resolution maps of the primeval cosmic microwave background showed that the overall large-scale geometry of the universe is surprisingly flat to unprecedented accuracy – a truly fundamental discovery.

- **ALIVE AFTER 250 MILLION YEARS: ISOLATION OF LIVE PERMIAN MICROORGANISMS** Recent interdisciplinary experiments conducted by NSF- supported researchers on salt crystals taken from the Permian Salado Formation in Southeastern New Mexico, have shown that some ancient crystals still contain viable micro-organisms trapped within tiny fluid inclusions. The careful use of stringent geological and microbiological selection criteria support the hypothesis that the bacteria are at least 250 million years old. The salt crystal that contained the organisms was taken from an ancient dissolution pipe located within primary sedimentary beds 564 meters below ground surface. The entire sedimentary layer was examined before removing the crystal, to be sure that the sample was taken from a primary bed. Two of these inclusions held trapped, microorganisms that were still viable. The isolated microbes are salt tolerant and respond to concentrated brines by forming spores. One of the organisms is related to several modern day bacilli but does have several unique characteristics.

- **LIFE IN EXTREME ENVIRONMENTS** The discovery of viable microbes in Lake Vostok accretion ice provided the first evidence that Lake Vostok, a large subglacial lake located 4 km (~2.5 miles) beneath the East Antarctic ice sheet, supports a microbial community. Results from the Vostok work was reported widely in the popular media and resulted in a

BBC documentary entitled "The Lost World". Studies on the accretionary ice of Lake Vostok have led to predictions of a large and diverse population of bacteria within the lake itself, and large interdisciplinary studies of Lake Vostok are planned for the near future. These investigations have implications for life on Earth and serve as models for future interplanetary investigations.

- **TECHNOLOGY SPIN-OFFS FROM GRAVITY** Fourteen billion years after the Big Bang, gravity is such a weak force that experiments to test gravity push the frontier of technology. Gravity is the least tested of all known forces in nature. Thus, any advance in our knowledge of gravity from laboratory experiments is of key importance. Recent laboratory tests have pushed measurements to new levels of accuracy, resulting in new technology spin-offs, such as:
  - Development of high power solid-state lasers, up to 120 watts;
  - Development of pre-stabilized laser power amplifiers, in collaboration with industry;
  - Advances in large optics and metrology with sub-Angstrom smoothness and losses approaching one part per million;
  - Innovative software originally designed for huge numerical calculations in relativity was applied to oil exploration analysis.

- **UNDERSTANDING FUNDAMENTAL ECONOMIC PHENOMENA** Research on risk sharing and financial markets has brought new and deeper understanding of fundamental economic phenomena. One line of discovery has dealt with individual behavior. How and why individuals fail to fully use available financial markets to buffer themselves against variations in their income has had important implications for economic policy. Another area of research concerns currency crises in the 1990s, where it has been found that the usual cause of currency crises – too rapid expansion of the money supply– was not a factor in the Asian crisis of 1998. Perhaps the most important result in this field stems from a recent discovery known as "Taylor's Rule," which has become a powerful and effective monetary policy guideline. What is the optimal Federal funds rate? According to Taylor's rule, the Fed should adjust the federal funds rate to respond to differences between actual and desired performance on the Fed's dual objectives of price stability and full employment. This is done by setting the real federal funds rate equal to 2% plus one half the difference between actual and targeted inflation and one half the percentage difference between actual and potential GDP (assumes potential real GDP growth of 3.5%). The nominal funds rate should be set equal to the targeted real funds rate plus actual inflation. The Federal Reserve and a growing number of central banks use the results of this NSF project to achieve sustained economic growth without high rates of inflation.

- **EDUCATION - IMPROVED ACHIEVEMENT IN MATHEMATICS AND SCIENCE SKILLS** This year NSF's continuing emphasis on systemic reform, teacher education and professional development has yielded exciting advances. In general, investments in educational systemic reform have led to increased achievement for a diverse student population and substantial narrowing of the gaps between minority and majority students. For example,

  - Over the first six years of the Miami-Dade Urban Systemic Initiative (USI), the median percentile scores on the Stanford-8 test for grade 4 students increased from 26 to 40 for African-Americans, from 26 to 59 for Hispanics, and from 74 to 77 for Whites, showing substantial progress toward closing the achievement gap.

  The Systemic Initiatives have also brought about substantial increases in the number of students taking more challenging science and mathematics courses in high school. For example,

  - Over a five-year period advanced placement science enrollment in Los Angeles USI schools increased by 53%, compared to 17% for non-USI schools in the city, with remarkable increases of 196% and 146% respectively for African-American and Hispanic students.

- **TRAINING WORLD-CLASS SCIENTISTS IN MODERN TECHNOLOGIES** NSF support provides a unique opportunity for undergraduates to have a "hands-on" exposure to science by working in NSF-funded laboratories. At Massachusetts Bay Community College, a program in biotechnology for minority students reaches a pool of under-served students, notably those from an urban community college, and provides them with opportunities for research at Boston University and other institutions, including field stations such as the Savannah River Ecology laboratory and Skidway Institute of Oceanography. A measure of the success of this program is that in the last five years it has produced eight recipients of the prestigious Barry M. Goldwater Scholarships for students planning to pursue a Ph.D. in science, mathematics or engineering.

- **INNOVATIVE RESEARCH AND EDUCATION EXPERIENCES** An important role for NSF is to catalyze innovation in the ways that we apply science, mathematics, and engineering. Undergraduate students participating in the Research Experiences for Undergraduates site at the Milwaukee School of Engineering helped solve a local murder case that had remained unsolved for 2 years. The students developed a technique for creating a facial image from a skull, which allowed police to determine the race of the victim. After this image was published in local newspapers, someone came forward to identify the victim as an immigrant from Africa, the clue that broke the case. The FBI is now interested in working with the Milwaukee School of Engineering to develop advanced forensic methods based on the modeling technique developed by the undergraduate students.

- **THE INTERNET** was based on experience gained from the Defense Advance Research Projects Agency-funded ARPANET that connected a few military labs and universities and established TCP/IP as the "language" of internetworking. Building on that experience, NSF funded a series of civilian network projects that led to the Internet of today. The CSNET of 1980 provided networking capability to computer science and engineering academic researchers and educators and encouraged this wider group of researchers and educators to engage in networking research and training. During the 1980's, CSNET was expanded as the NSFNET to connect university researchers to the NSF funded supercomputer sites and to NCAR. This increased the demand and uses for packet-based networks and drew the private sector into developing the expertise to further expand the technology. Major accomplishments in the 1980's include the design of the architecture for Internet routers that provided the foundations for companies such as Cisco and Bay Networks, the domain name system that gives us World Wide Web addresses such as www.nsf.gov or www.cisco.com, and the structure for connecting networks of different owners. In 1992, Congress asked NSF to open the Internet to competition and plan for its privatization. The result led to the system of Internet Service Providers and backbone providers that is now the acclaimed Internet.[1] Continuing development for the Internet includes very high-speed services, vBNS by NSF and Internet2 by the private sector, as well as applications support from NSF for scientific visualization, the sharing of scientific data sets, and distributed computing on "grids" of computers. The Internet is surely one of NSF's premier long-range impacts of the last decade.

- **COPING WITH INTERNET TRAFFIC GROWTH** Internet traffic is growing at an incredible pace. While optical communications technologies are well able to accommodate these increases, a severe bottleneck is the electronics implementing the packet routing functions. NSF-supported research in how Internet routers look up addresses rapidly to achieve high speed throughput is leading to new information to cope with speed issues. New techniques have decreased the address lookup time by a factor of eight, without having to add new hardware. The ideas have been patented and licensed to several routing-equipment manufacturers, including Lucent, GTE, NEC, Microsoft, Onex and Quary Systems. NSF's research support has created an entirely new approach to designing high speed internet routers, estimated to comprise a several billion dollar per year market segment.

[1] *Funding a Revolution - Government Support for Computing Research*, Computer Science Telecommunications Board of the National Research Council 1999, National Academy Press, 286 pages. This extended study has a detailed history of the ARPANET and Internet and places the development in a broader context of networking research and development.

FY 2000 NOBEL PRIZE WINNERS

Of the 11 Nobelists announced in 2000, six have been supported by NSF at some time in their careers. This is consistent with an historical connection: of about 400 Nobelists named since 1960, 109 have received NSF funding. This year's NSF-funded Nobelists - neuroscientist Paul Greengard, physicist Herbert Kroemer, chemists Alan Heeger and Alan MacDiarmid, and economists James Heckman and Daniel McFadden – demonstrate and reflect the multi-disciplinary influence of NSF support. Some have been funded by NSF for decades, and together they have received dozens of merit-reviewed NSF grants.

James Heckman and Daniel McFadden, who share the 2000 Nobel Prize in economics for their development of statistical methods that are widely used in the social sciences for predicting group behavior and evaluating the impact of public programs, have long been supported by the National Science Foundation. Dr. Heckman has been principal investigator on 21 NSF grants and Dr. McFadden on 33 grants since the 1970s. Dr. McFadden used his economic theory methods to help design the BART transportation system in San Francisco, guide investments in phone service, and allocate housing for the elderly. More recently, McFadden has developed new conceptual approaches and statistical methods for estimating the value of natural resources, used in such applications as quantifying the welfare losses due to the Exxon Valdez oil spill.

For a list of 2000 Nobel laureates, see: http://www.nobel.se/announcement/2000/index.html. For historical context on NSF's connection to the Nobel prizes, see: http://www.nsf.gov/od/lpa/news/media/2000/nsfnobels.html.

III. ASSESSMENT AND EVALUATION PROCESS

Implementing the Government Performance and Results Act of 1993 (GPRA) has been a challenge for NSF and other agencies having missions that support basic research and education activities. Both the substance and timing of outcomes from research and education activities are unpredictable. This creates difficulty in linking outcomes to annual investments and the agency's annual budget. The true value of NSF is seen in the long-term results of research and education activities that may require many years to develop and can only be judged retrospectively.

Therefore, NSF developed and obtained Office of Management and Budget (OMB) approval for use of the "alternative form". The alternative form allows NSF to assess progress annually using a retrospective approach and a qualitative scale for its Outcome Goals. In using this approach, NSF depends on external experts to assess the quality of research and education results and to judge the annual progress NSF is making toward achieving its Outcome Goals.

In addition, NSF's goals are agency-wide goals. NSF aggregates results across the entire agency to report annual progress in meeting each goal. Aggregation is accomplished by compiling many reports provided by external experts for the Outcome Goals, and integrating those results with the results of the Management and Investment Process Goals.

Because the conduct of research and education activities in science and engineering supported by NSF takes place outside the agency, external factors have a significant impact on NSF's performance. The circumstances of our institutional partners in academia, the private sector, and the government determine how individuals are able to respond in both proposing and conducting research and education activities responsive to NSF's goals.

A. TYPES OF GOALS

NSF employs a mix of both qualitative and quantitative goals, and makes use of both qualitative information and quantitative data in determining annual progress made toward goal achievement. NSF's Outcome Goals are expressed in a qualitative form, and most Management Goals and Investment Process Goals are quantitative.

B. TYPES OF ASSESSMENTS

NSF has traditionally made use of various types of assessments and evaluations to monitor quality and process. Programs and plans are assessed and evaluated throughout the year on a continuing basis by internal staff and senior management. Evaluations are carried out by externally-contracted groups to review the progress of programs in meeting specific program objectives. NSF engages committees of external experts or evaluators, called Committees of Visitors (COVs), and Advisory Committees (ACs), to review program practices, processes, and results for the Outcome Goals. The Management and Investment Process Goals are reviewed internally by NSF staff and audited by third parties.

To determine program performance toward meeting the Outcome Goals, NSF depends on assessments provided by the COVs and ACs. Each NSF program has traditionally been assessed by COVs on a three-year cycle for quality of science and integrity of process. Each year, COVs assess a one-third portion of NSF's portfolio, looking at the program performance over the previous three years. COVs review practices and processes, and, with the implementation of GPRA, include an assessment of results. The schedule for COVs has been impacted by GPRA. Programs may be clustered together and evaluated as a group by COVs, to facilitate the assessment process. This has led to rescheduling COVs for some programs to accommodate the GPRA schedule.

In FY 2000, about 37% of NSF's portfolio of 200 programs were evaluated by COVs for quality of process and progress made in achieving NSF's Outcome Goals. Last year, about 40% of NSF's portfolio that was evaluated by COVs. The remaining portions of NSF's portfolio will be evaluated by COVs in FY 2001 to complete the full three-year cycle of assessment of NSF's programs under GPRA.

Approximately 250 COV members and 150 advisory committee members participated in the performance assessment process in FY 2000. Together, for the Outcome Goal assessment process alone, COVs and ACs generated a total of 64 reports which covered 78 of NSF's approximately 200 programs (see Section XV. for a schedule of program evaluations)[2]. We anticipate that electronic copies of the COV and advisory committee reports will become available in December 2001.

NSF makes use of internal data systems to monitor and report progress in achieving the quantitative Management Goals and Investment Process Goals. With the exception of one Investment Process Goal (Investment Goal 2), these goals and results are assessed and reviewed by internal management and staff rather than by external committees.

Reviews by external groups provide useful information for identifying issues, establishing new goals, and redirecting efforts. Changes to programs and plans may be necessitated by difficulty in meeting a goal, lack of appropriateness of a goal, or an inability to measure a goal. Some FY 2001 and FY 2002 goal levels are being adjusted based on FY 1999 and FY 2000 results, and on

[2] In several instances, a single COV report evaluates more than one program.

realistic expectations for future progress. Changes of this type are handled through performance plans and internal management. Major changes, when necessary, are handled through revisions to the Strategic Plan, and make use of input provided by external Advisory Committees.

C. ASSESSMENT PROCESSES

Assessments and evaluations for gauging progress in achieving NSF's goals involve different steps for the different types of goals. In FY 1998, NSF developed and established new reporting systems and procedures, reporting guidelines, and templates to enable the collection, assessment, and analysis of the qualitative information and quantitative data necessary for reporting performance across the agency. The systems and templates are continually upgraded and revised for reporting using feedback from previous experiences. The reporting templates were developed to permit more uniform and consistent reporting of the qualitative goals across the agency.

For the quantitative Management and Investment Process Goals, the assessment process is straightforward. The agency collects relevant data using internal corporate data systems and compares the result with the performance level targeted for the fiscal year. Most quantitative goals are evaluated on a quarterly basis, with the information undergoing review by senior management. In FY 2000, an agency-wide GPRA module for data relevant to the quantitative goals was developed to enable staff to follow or track their progress throughout the year.

For the qualitative Outcome Goals, NSF programs are judged by groups of external evaluators. The following discussion focuses primarily on Outcome Goal assessment. NSF receives and maintains performance information in the form of reports from external COVs and ACs, whose meetings are subject to Federal Advisory Committee Act rules.

Assessment of goal achievement by external evaluators takes into account such factors as:

- identified performance indicators for each performance goal;
- the success to which NSF strategies and plans are implemented;
- the level of resources invested;
- external events beyond control of the agency; and
- the agency's capability to be flexible and respond rapidly to emerging opportunities.

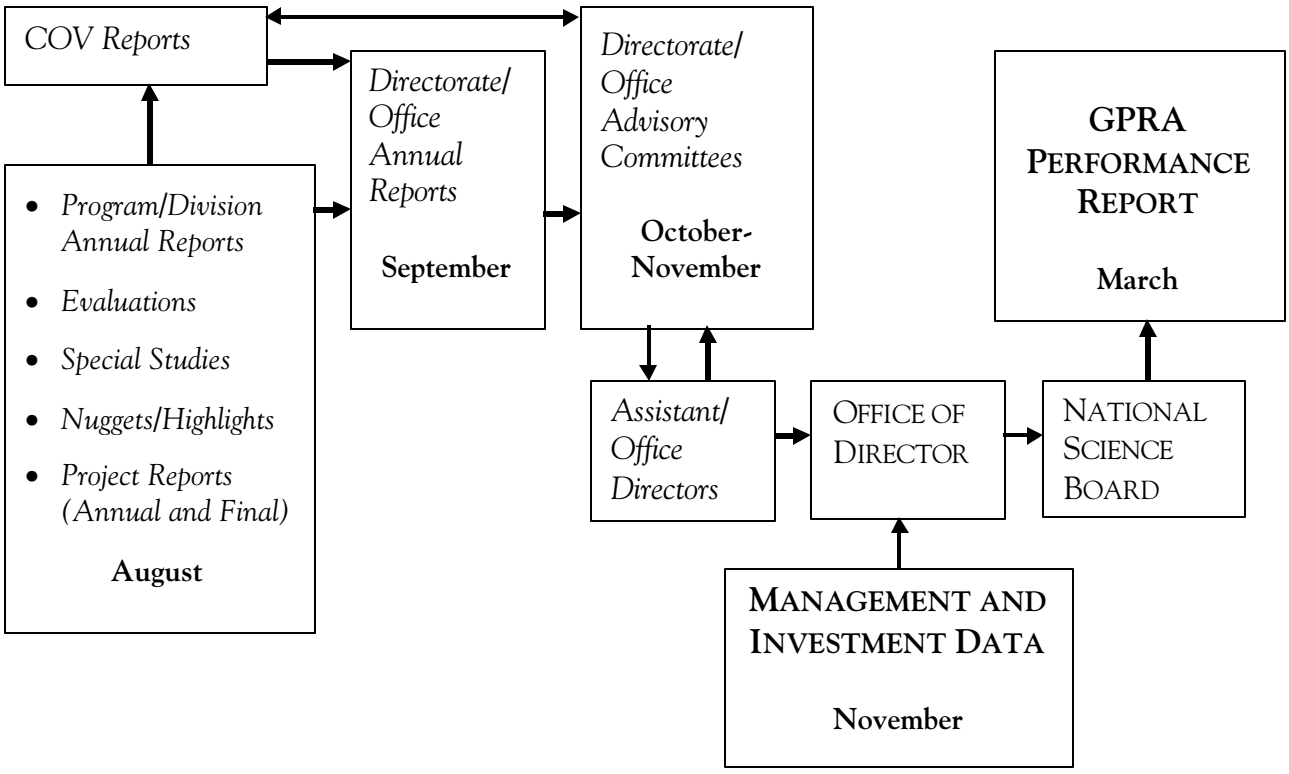
The focus of this portfolio assessment is the quality of past investments (the quality of outputs and outcomes) and the likelihood that the package of awards will produce strong results in the future.

Much of this performance assessment is retrospective, addressing investments made at some time in the past. NSF performance is *successful* if the outcomes of NSF investments reported during a fiscal year are judged to have achieved or to have made significant progress in achieving the specific performance goals. COVs use their collective experienced-based norms in determining the level of "significance" necessary for a rating of successful. COVs also address the quality of the sets of awards made and the integrity of the process for the period under review.

External COVs review approximately one-third of NSF's programs each year, so that all programs have been reviewed at the end of a three-year period. The judgements contained in COV reports and AC reports are combined with data from internal databases, and are integrated by NSF management to form the basis for NSF's performance report.

The flow-chart below represents the overall assessment process for the Outcome Goals and shows how data for the Management Goals and Investment Process Goals are submitted for integration in NSF's Performance Report. NSF staff prepare materials as input for the COVs (reports, evaluations, studies, highlights), for use by COVs in developing their reports and making their assessments. The COV reports are used by NSF staff in preparing directorate/office annual reports, and are also reviewed and approved by directorate/office ACs. Each directorate/office must prepare a subsequent response to the recommendations of the COVs, which is reviewed by the directorate/office AC. Directorates/offices also prepare an annual report for AC review (in October and November) which summarizes activities of the directorate/office for the fiscal year in addition to the activities examined in the COV process. The process culminates with the AC report, which caps the annual progress of the directorate toward achieving NSF's Outcome Goals.

OUTCOME RESULTS DATA



At the close of the fiscal year, each directorate submits all GPRA-related supporting materials (COV and AC reports, directorate annual reports, and responses to recommendations made by COVs) to the Office of the Director. Simultaneously, data relevant to the Management Goals and Investment Process Goals are finalized by NSF staff and submitted to the Office of the Director.

NSF makes use of several stages in the proposal and award process to assess performance. These include the following steps:

- **APPLICANT AND GRANTEE INFORMATION/MERIT REVIEW**

  All applicants and grantees provide results from previous NSF support, information about existing facilities and equipment available to conduct the proposed research and education, location of proposed activities, biographical information on the primary investigators, other sources of support, and certifications specific to NSF. Information is required at the time of application, at the time of an award, and in annual and final project reports. Awards are made based on merit review by peers who are experts in the field using NSF's merit review criteria, and the availability of resources. Award decisions also take into account the quality of prior results. This type of information is part of the package of information made available to COVs when assessing program performance toward meeting Outcome Goals.

- **ANNUAL PROGRESS REVIEW BY PROGRAM OFFICERS**

  Program officers review the annual progress of awards that have a duration longer than one year. This review typically takes place before the anniversary date of the award and prior to the release of any continuing funds. The Principal Investigator (PI) responsible for the award submits the annual progress report electronically via FastLane. The progress report includes information on significant accomplishments, progress achieved in the prior year, plans for the next year consistent with the proposed project, and points out issues that may impact progress or completion of the project on schedule and within budget. Once this report is approved, funds for the ensuing year are approved by the administering program officer and released. Annual progress reports are made available to COVs for during the assessment process.

- **PROGRAM EVALUATION BY COMMITTEES OF VISITORS (COVS)**

  To ensure the highest quality in processing and recommending proposals for awards NSF convenes committees of qualified external evaluators (COVs) to review each program every three years. Strict guidelines are followed in selecting COV members to ensure independence, programmatic coverage, and balanced representation. COVs are committees composed of independent, external experts from academia, industry, government, and the public sector.

  COVs have traditionally assessed the integrity and efficiency of the processes for proposal review. With the implementation of GPRA in FY 1999, NSF added a retrospective

assessment of the quality of results of NSF's programs in the form of outputs and outcomes. NSF asks COVs to report on the noteworthy achievements of each year, to identify 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.

In FY 2000, COVs were asked to judge whether NSF programs were successful or not in achieving Outcome Goals 1-4.a, and in implementing the merit review criteria (Investment Goal 2). To conduct their assessments, COVs use a standardized reporting template with a set of core questions addressing process, program management, and quality of outcomes. COVs are asked to justify their judgements and provide examples illustrating success. The results of their judgements are aggregated and collectively weighed to determine NSF's overall progress in achieving the Outcome Goals.

Each COV typically consists of between six and twelve members who review one or more programs over a two day period. In FY 2000 approximately 250 COV members participated in the performance assessment process. The Outcome Goal assessment process generated 55 COV reports covering 78 of NSF's approximately 200 programs (see Section XV for a schedule of program evaluations). Typically, there are fewer COV reports than programs as some reports evaluate clusters of programs. Electronic copies of COV reports will become available in December, 2001.

- **DIRECTORATE/OFFICE ASSESSMENT BY ADVISORY COMMITTEES (ACS)**

  Eight Advisory Committees (ACs) advise the seven directorates and the Office of Polar Programs (OPP). Advisory Committees are composed of external experts who have broad experience in academia, industry, and government. Each AC typically has 18-25 members to work with the NSF in assessing annual progress.

  Advisory committees annually review COV reports, available internal and external assessments, and directorate/OPP annual reports to judge program effectiveness and to report on strengths and weaknesses. In FY 2000 approximately 150 advisory committee members participated in the performance assessment process. Each AC reviews the portfolio of its respective directorate/office for progress in achieving NSF's Outcome Goals.

  In their assessment capacity ACs respond to a set of standardized questions developed by NSF staff to indicate the success of the directorate/OPP in achieving each Outcome goal, and to provide a justification for their assessment. NSF management reviews the eight Advisory Committee reports and integrates the assessments into the NSF Annual Performance Report.

AGGREGATION OF COMMITTEE REPORTS

All COVs and Advisory Committees are asked to complete a report template with questions addressing how well programs achieve NSF's goals. Committees are asked to address (A) the integrity and efficiency of the **processes** which involve proposal review; and (B) the quality of the **results** of NSF's investments. However, each goal may not apply to each program being evaluated, and therefore a goal may not be rated in every report. For example, in FY 2000 only 58% of all reports gave a rating for Goal 4.a. In many cases where the goals are not rated, committee reports provided comments indicating either full success, limited success, or indicated that the goal did not apply to the programs under review. In some cases the committee may not have had adequate information to provide a rating. Information may not have been available where programs were too new to have produced results for this report period.

Most committees provided a rating with sufficient information to justify how they arrived at the rating. Some committees provided comments that could be used to determine the success of a program. This year, to arrive at an aggregated result for the agency, comments provided in reports were used when ratings for a goal were not evident, provided that the comments were clearly relevant and sufficiently well justified. In cases where a high rating was assigned, but comments indicated performance was not fully successful, the comments were used to determine a rating. Committee reports were reviewed and results were tabulated for each goal. A tabulated summary was produced which combined results across the agency for each goal. In FY 2000, the tabulated summary was audited by PricewaterhouseCoopers LLP for Outcome Goals 1, 2, 3, and 4.a, and Investment Process Goal 2.

D. HOW ASSESSMENTS AND EVALUATIONS ARE UTILIZED

NSF management reviews program annual reports, reports by COVs, reports by ACs, and reports by other external groups or organizations. NSF management writes a response to the performance issues raised in COV reports, and submits this response to the relevant AC for review, identifying steps that will be implemented to address specific issues raised in the COV reports. The NSF management review the recommendations and issues that are raised in the COV and AC reports in order to identify management concerns as well as areas of scientific opportunity. COV and AC reports address a broad range of issues ranging from staffing and quality of merit review to specifics of a scientific issue. They extend beyond the scope of the GPRA goals, and have traditionally been used by NSF management to improve program performance and set funding priorities.

INTEGRATING NSF'S PERFORMANCE REPORT

NSF aggregates the performance results for Goals on Management, Investment Process, and Outcomes. This produces a report which is a combination of quantitative data collected and prepared by the agency for the Management Goals and Investment Process Goals, and qualitative judgements provided by external experts for the Outcome Goals.

COV reports and Advisory Committee reports form the basis for the Outcome Goal results. The judgements provided in reports are tabulated, analyzed, and aggregated across the agency for each Outcome Goal, to arrive at an assessment of the agency performance – the annual progress of the agency toward meeting the Outcome Goals. To support the outcome results, illustrative examples of outcomes are selected from COV and Advisory Committee reports, directorate/office annual reports, and other sources such as project reports, newspaper articles, or publications.

NSF staff integrate the results of the Investment Process Goals and Management Goals with the Outcome Goal results to produce this report. The resulting information is used in preparing the annual performance plans and internal management plans. The systems for FY 2000 data collections for the Management and some Investment Process Goal results, and the data tables for the Outcome Goals (1, 2, 3, and 4.a) and Investment Process Goal 2 were audited by PricewaterhouseCoopers LLP and reviewed by KMPG.

IV. SUMMARY TABLE OF FY 2000 PERFORMANCE GOALS AND RESULTS

A. AGENCY RESULTS FOR FY 2000

Overall, NSF was successful in achieving 64% – 18 of 28 – of its performance goals. Results in this second year are consistent with those obtained in FY 1999. For example, the following areas were identified as needing improvement: (1) use of both merit review criteria by reviewers and applicants; (2) customer service goals such as decreasing time to decision on proposals; and (3) increasing participation of under-represented groups. NSF will continue to focus on achieving improved performance in these areas in FY 2001 and beyond.

NSF was more rigorous this year in evaluating goal achievement than last year. Options for grading the qualitative Outcome Goals were limited to either *successful* or *not successful* and justification was required for *successful* ratings.

Characterization of NSF's performance for goals stated in the alternative form in FY 2000 benefited from changes made in presentation, process, and use of information from external committees of experts. Changes resulted, in part, from reviews of NSF's FY 1999 Performance Report made by the Administration, Congress, and the private sector that raised issues of quality of information, appropriate justification of ratings, and that questioned NSF's use of a two-tiered rating schema. To alleviate these concerns, NSF engaged an external firm in FY 2000, PricewaterhouseCoopers LLP, to verify achievement data for most goals.

FY 2000 AGGREGATED PERFORMANCE RESULTS

	Number of Goals Achieved
Outcome Goals	6 out of 8 (75%)
Management Goals	5 out of 6 (83%)
Investment Process Goals	7 out of 14 (50%); one goal did not apply
TOTAL	18 out of 28 (64%)

Aggregated performance results for the agency are presented in brief summary form for each goal in Table 1. Each goal is defined in the table, and results for the goal are briefly stated. A more complete discussion of results for each goal is presented in Section V.

RESULTS FOR OUTCOME GOALS

Six of the eight Outcome Goals (75%) were achieved in FY 2000. External evaluators indicated that NSF successfully achieved Outcome Goals 1 and 2. Information provided by external evaluators indicated that NSF did not achieve Outcome Goals 3 and 4.a, although they noted that NSF performance had improved. NSF also achieved the quantitative Outcome Goals 4.b, 4.c, 5.a and 5.b.

External evaluators commented that programs are showing improvement over FY 1999 performance in the area of increasing diversity through increased participation of under-represented groups. However, they indicated that participation remains lower than expected. Evaluators commented that increasing participation of under-represented groups is an area needing more attention by NSF. In addition, evaluators noted that some NSF program portfolios should include more "high risk" activities. Common issues emerged that could result in reduced program performance; these issues include increasing workload issues and delays in processing proposals (see Investment Process Goal 7). Further discussion of Outcome Goal results and how NSF is addressing these issues as well as others is provided in Section V.A.

RESULTS FOR MANAGEMENT GOALS

Five of NSF's six Management Goals (83%) were achieved in FY 2000. Performance improvements were identified in the orientation and training of NSF staff using FastLane, NSF's electronic system for proposal submission, proposal review, project reporting, and increasing the use of the electronic Project Reporting System for project reporting by awardees.

One Management Goal was not achieved involving NSF's development of the technological capability to submit proposals electronically. The difficulty encountered in FY 2000 which prevented this goal from being achieved, was the establishment of electronic signature protocols. In FY 2001 NSF will pilot ten full electronic review projects to assess the effectiveness of its electronic signature protocols. Further discussion of the Management Goals is provided in Section V.B.

RESULTS FOR INVESTMENT PROCESS GOALS

Seven of NSF's fifteen Investment Process Goals were achieved in FY 2000; seven were not achieved and one of the facility goals did not apply (because there were no construction projects completed during the year). Areas identified as needing improvement include: use of the new merit review criteria by reviewers and applicants; identifying best practices and training for improving customer service; allowing three months time to prepare proposals; decreasing the time to decision; increasing the percentage of awards to new investigators; maintaining facility upgrades and construction on schedule; and keeping operating time lost due to unscheduled downtime to less than 10% of the total scheduled operating time. Discussion of these goals and how NSF is addressing issues is provided in Section V.C.

Table 1 provides a brief summary of the results for each FY 2000 goal which appeared in the NSF FY 2000 Performance Plan. For more detail and discussion of results and goals, see Section V of this report.

TABLE 1. FY 2000 PERFORMANCE GOALS AND RESULTS

ANNUAL PERFORMANCE GOALS AND RESULTS FOR OUTCOMES

OUTCOMES	PERFORMANCE GOALS FOR OUTCOMES	RESULTS
	NSF is judged successful when	
OUTCOME GOAL 1: Discoveries at and across the frontier of science and engineering	**PERFORMANCE GOAL 1:** 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, as judged by independent external experts.	**Baseline:** Experiments using FY 1997 and FY 1998 information indicated successful achievement. **FY 1999:** Goal achieved. Judged successful by external experts in all reports. **FY 2000:** Goal achieved. Reports by external experts indicate that in the aggregate NSF is successful in achieving this goal.
OUTCOME GOAL 2: Connections between discoveries and their use in service to society	**PERFORMANCE GOAL 2:** 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, as judged by independent external experts.	**Baseline:** Experiments using FY 1997 and FY 1998 information indicated successful achievement. **FY 1999:** Goal achieved. Judged successful in the aggregate by external experts who noted improvements can be made in some programs. **FY 2000:** Goal achieved. Judged successful in the aggregate by external experts who noted improvements can be made in some programs, as in FY 1999.
OUTCOME GOAL 3: A diverse, globally-oriented workforce of scientists and engineers	**PERFORMANCE GOAL 3:** Participants in NSF activities experience world-class professional practices in research and education, using modern technologies and incorporating international points of reference; when academia, government, business, and industry recognize their quality; and when the science and engineering workforce shows increased participation of under-represented groups, as judged by independent external experts.	**Baseline**: Experiments using FY 1997 and FY 1998 information indicated successful achievement. **FY 1999**: Goal achieved**.** Judged successful in most areas by external experts. **FY 2000**: Judged successful in a limited context– goal not fully achieved in the aggregate. Most programs with specific responsibilities for these areas were judged successful. Improvements still needed in the same areas that were identified in FY 1999.

ANNUAL PERFORMANCE GOALS AND RESULTS FOR OUTCOMES – CONTINUED

OUTCOMES	PERFORMANCE GOALS FOR OUTCOMES	RESULTS
OUTCOME GOAL 4: Improved achievement in mathematics and science skills needed by all Americans	**PERFORMANCE GOAL 4.a:** 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, as judged by independent external experts.	**Baseline:** Preliminary pilot efforts did not provide sufficient information to yield a valid baseline. **FY 1999:** Goal achieved. Judged successful in the aggregate by external experts for programs to which goal applies. **FY 2000:** NSF was judged successful in a limited context in the aggregate, and reports this goal as not fully achieved overall. NSF was successful where programs had clear objectives directed toward this goal.
	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:** Goal achieved. **FY 2000:** Goal achieved.
	PERFORMANCE GOAL 4.c: Through systemic initiatives and related teacher enhancement programs, NSF will provide intensive professional development experiences annually for at least 65,000 precollege teachers.	**FY 1999:** Goal achieved. **FY 2000:** Goal achieved.

ANNUAL PERFORMANCE GOALS AND RESULTS FOR OUTCOMES– CONTINUED

OUTCOME	PERFORMANCE GOALS FOR OUTCOMES	RESULTS
OUTCOME GOAL 5: Timely and relevant information on the national and international science and engineering enterprise.	**PERFORMANCE GOAL 5.a:** Maintain FY 1999 gains in timeliness for an average of 486 days as the time interval between reference period (the time to which the data refer) and reporting of data. FY 1999-2000 Goal 486 days Actual 461 days	**Baseline**: 540 days in 1995-1996. **FY 1999:** Goal achieved. **FY 2000:** Goal achieved.
	PERFORMANCE GOAL 5.b: Establish a standard set of data quality measures for reporting of Science Resource Studies products. Prepare reports on these measures for all SRS surveys and publish them in electronic formats to inform users of SRS data quality. New in FY 2000, replacing the FY 1999 goal on relevance.	**Baseline:** New goal in FY 2000. **FY 2000:** Goal achieved.

ANNUAL PERFORMANCE GOALS AND RESULTS FOR MANAGEMENT

PERFORMANCE AREA	PERFORMANCE GOALS FOR MANAGEMENT	RESULTS
NEW AND EMERGING TECHNOLOGIES		
Electronic proposal submission	**MANAGEMENT GOAL 1:** NSF will receive at least 60% of full proposal submissions electronically through FastLane. FY 1997 / FY 1998 / FY 1999 / FY 2000 / FY 2001 Baseline 4.4% 17% Goal 25% 60% 95% Result 44% 81%	**FY 1999:** Goal achieved. **FY 2000:** Goal achieved.
Electronic proposal processing	**MANAGEMENT GOAL 2:** By the end of FY 2000, NSF will have the technological capability to take competitive proposals submitted electronically through the entire proposal and award/declination process without generating paper within NSF.	New goal in FY 2000. **FY 2000:** Goal not achieved.

ANNUAL PERFORMANCE GOALS AND RESULTS FOR MANAGEMENT – CONTINUED

PERFORMANCE AREA	PERFORMANCE GOALS FOR MANAGEMENT	RESULTS
NSF STAFF		
Diversity	**MANAGEMENT GOAL 3:** In FY 2000, NSF will show an increase over 1997 in the total number of hires to S&E positions from under-represented groups. **FY 1997 Baseline**: Of S&E hires in 1997, 16 were female and 15 were from under-represented minority groups. **FY 2000 Result**: Of 113 S&E hires, 35 were female and 19 were from minority groups. Compared with FY 1997 baseline, this represents a 120% increase in female hires and a 27% increase in minority hires.	New goal in FY 2000. **FY 2000:** Goal achieved.
Capability in use of information technology	**MANAGEMENT GOAL 4:** By the end of FY 2000, all staff will receive an orientation to FastLane, and at least 80% of program and program support staff will receive practice in using its key modules. Orientation — FY 1999 / FY 2000 / FY 2001 Goal: 100% / 100% / * Result: 80% / 100% Training Goal: 95% / 80% / * Result: 43% / 90% * will not be shown as a goal in FY 2001	**FY 1999:** Goal not achieved. **FY 2000:** Goal achieved.
IMPLEMENTATION OF MANAGEMENT REFORMS		
Year 2000	**MANAGEMENT GOAL 5:** NSF will complete all activities needed to address the Year 2000 problem for its information systems according to plan, on schedule and within budget. **Result:** All activities needed to address the Year 2000 problem were completed according to plan, on schedule, and within budget.	**FY 1999:** Goal achieved; revised for FY 2000. **FY 2000:** Goal achieved.
Project Reporting System	**MANAGEMENT GOAL 6:** During FY 2000, at least 85% of all project reports will be submitted through the new electronic Project Reporting System. FY 1999 / FY 2000 Goal: 70% / 85% Result: 59% / 92%	**FY 1999:** Goal achieved; target revised for FY 2000. **FY 2000:** Goal achieved.

ANNUAL PERFORMANCE GOALS AND RESULTS FOR INVESTMENT PROCESS

PERFORMANCE AREA	PERFORMANCE GOALS FOR INVESTMENT PROCESS	RESULTS
PROPOSAL AND AWARD PROCESSES		
Use of Merit Review	**INVESTMENT GOAL 1:** 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. Baseline / Goal / Result FY 1998: 90%* FY 1999: Goal 90%*; Result 95%* *FY 2000*: Goal *80%** (was 90%*)*; Result *87%** (95%)** FY 2001: Goal 85%** **Based on old definition.* ***Based on most recent revisions of definitions by OMB.*	**FY 1999:** Goal achieved. **FY 2000:** Goal achieved.
Implementation of Merit Review Criteria	**INVESTMENT GOAL 2:** 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, as judged by external independent experts. **FY 1999 Result:** Largely successful as judged by experts. Needs improvement. **FY 2000 Result:** Not fully successful as judged by experts. Needs improvement.	**FY 1999:** Goal achieved. **FY 2000:** Goal not achieved.
Customer service – General	**INVESTMENT GOAL 3:** Identify possible reasons for customer dissatisfaction with NSF's merit review system and with NSF's complaint system. New goal in FY 2000; not continued in FY 2001. **FY 2000 Result:** An external customer service survey of NSF applicants was conducted in FY 2000.	New goal in FY 2000. **FY 2000**: Goal achieved.
Customer service – General	**INVESTMENT GOAL 4:** Identify best practices and training necessary for NSF staff to conduct merit review and answer questions about the review criteria and process; identify best practices and training necessary for NSF staff to answer questions from the community and to deal with complaints in a forthright manner. **FY 2000 Results:** Goal not completed in FY 2000. Plans to finalize implementation in FY 2001.	New goal in FY 2000. **FY 2000:** Goal not achieved.

ANNUAL PERFORMANCE GOALS FOR INVESTMENT PROCESS –CONTINUED

PERFORMANCE AREA	PERFORMANCE GOALS FOR INVESTMENT PROCESS	RESULTS
Customer service – General	**INVESTMENT GOAL 5:** Improve NSF's overall American Customer Satisfaction Index (ACSI) compared to the FY 1999 Index of 57 (on a scale of 0-100). **FY 2000 Results:** NSF achieved an ACSI index of 58 in FY 2000.	New goal in FY 2000. **FY 2000:** Goal achieved.
Customer service – Time to prepare proposals	**INVESTMENT GOAL 6:** 95% of program announcements and solicitations will be available at least three months prior to proposal deadlines or target dates. Baseline: FY 1998 66% Goal: FY 1999 95%; FY 2000 95%; FY 2001 95% Result: FY 1999 75%; FY 2000 89%	**FY 1999:** Goal not achieved. **FY 2000:** Goal not achieved.
Customer service – Time to decision	**INVESTMENT GOAL 7:** Maintain the FY 1999 goal to process 70% of proposals within six months of receipt, improving upon the FY 1998 baseline. Baseline: FY 1998 59% Goal: FY 1999 70%; FY 2000 70%; FY 2001 70% Result: FY 1999 58%; FY 2000 54%	**FY 1999:** Goal not achieved. **FY 2000:** Goal not achieved.
Maintaining openness in the system	**INVESTMENT GOAL 8:** The percentage of competitive research grants going to new investigators will be at least 30%. Baseline: FY 1998 27% Goal: FY 1999 30%; FY 2000 30%; FY 2001 30% Result: FY 1999 27%; FY 2000 28%	**FY 1999:** Goal not achieved. **FY 2000:** Goal not achieved.

ANNUAL PERFORMANCE GOALS FOR INVESTMENT PROCESS—CONTINUED

PERFORMANCE AREA	PERFORMANCE GOALS FOR INVESTMENT PROCESS	RESULTS
INTEGRATION OF RESEARCH AND EDUCATION		
In Proposals	**INVESTMENT GOAL 9:** 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. **Result:** In FY 2000, NSF implemented an electronic program announcement template clearance process (PAT) that is used by NSF staff to generate announcements and solicitations. Use of the PAT ensures that the integration of research and education is emphasized in all announcements and solicitations for PIs to address in their submissions.	New goal in FY 2000. **FY 2000:** Goal achieved.
In Reviews	**INVESTMENT GOAL 10:** NSF will develop and implement a system/mechanism to request and track reviewer comments tied to merit review criterion #2, "what are the broader impacts of the proposed activity?" (Revised goal.) No baseline. **Result:** In FY 2000, screens in FastLane were redesigned so that reviewers can address each merit-review criterion separately. The performance data will be collected from the FastLane database. This will be fully implemented in FY 2001.	New goal in FY 2000. **FY 2000:** Goal achieved.
DIVERSITY		
NSF Applicants	**INVESTMENT GOAL 11:** NSF will identify mechanisms to increase the number of women and under-represented minorities in the proposal applicant pool, and will identify mechanisms to retain that pool. **Result:** NSF identified and put into place mechanisms to increase the diversity of NSF applicants.	New goal in FY 2000. **FY 2000:** Goal achieved.

PERFORMANCE AREA	PERFORMANCE GOALS FOR INVESTMENT PROCESS	RESULTS
FACILITIES OVERSIGHT		
Construction and upgrade	**INVESTMENT GOAL 12:** Maintain FY 1999 goal to keep construction and upgrades within annual expenditure plan, not to exceed 110 percent of estimates. **FY 1999 Result:** Majority of facilities were within 110 % of annual spending estimates. **FY 2000 Result:** Of the eleven construction and upgrade projects supported by NSF, all were within annual expenditure plans; most were under budget.	**FY 1999:** Goal achieved. **FY 2000:** Goal achieved.
	INVESTMENT GOAL 13: Maintain FY 1999 goal to 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:** Majority of facilities on schedule. **FY 2000 Result:** Of the eleven construction and upgrade projects supported by NSF, seven (64%) were within the annual schedule goal and four were not.	**FY 1999:** Goal achieved. **FY 2000:** Goal not achieved.
	INVESTMENT GOAL 14: For all construction and upgrade projects initiated after FY 1996, keep total cost within 110 percent of estimates made at the initiation of construction. **FY 1999 Result:** Did not apply in FY 1999. **FY 2000 Result:** This goal did not apply in FY 2000.	**FY 1999:** Goal did not apply in FY 1999. **FY 2000:** Goal did not apply in FY 2000.
Operations	**INVESTMENT GOAL 15:** Maintain FY 1999 goal to keep operating time lost due to unscheduled downtime to less than 10 percent of the total scheduled operating time. **FY 1999 Result:** Reporting data base under development. **FY 2000 Result:** Of the 26 reporting facilities, 22 (85%) met the goal of keeping unscheduled downtime to below 10% of the total scheduled operating time.	**FY 1999:** Inconclusive. **FY 2000:** Goal not achieved.

V. FINDINGS FROM PROGRAM ASSESSMENTS AND EVALUATIONS

Findings for program assessments and evaluations completed in FY 2000 for the Outcome Goals are discussed in Section V.A., followed by agency results for the Management Goals (Section V.B.), and Investment Process Goals (Section V.C.). It is important to note that, with the exception of Investment Process Goal 2, the findings for the Management Goals and Investment Process Goals are prepared by NSF staff with the use of central data systems, and are not judged in the COV assessment process.

The findings for Outcome Goals include summarized judgments reported in the Committee of Visitor (COV) and Advisory Committee (AC) assessment reports. General findings and goal ratings in COV and AC reports are aggregated across NSF, and summarized in a qualitative format for Outcome Goals 1, 2, 3, and 4a, in the following Section V.A.. The COV and AC reports are also the sources of results for Investment Goal 2, presented in Section V.C.

For each Outcome Goal, a brief introduction to the Goal is provided, followed by the annual performance goal and indicators for this fiscal year. Aggregated results of the assessment process follow the Performance Indicators, and a discussion of performance and plans for the next year is presented. Examples of results demonstrating successful performance as identified by COVs and ACs in the assessment process are presented to illustrate the impact of NSF support. Examples of results are organized by goal and area of emphasis, as described in the FY 2000 Performance Plan. Examples of Outcome results may be relevant to more than one goal or more than one area of emphasis.

In addition to the assessments provided by COVs and ACs, studies and evaluations are carried out by independent contractors to address specific issues not specifically linked to the GPRA performance goals. Evaluations completed in FY 2000 are presented in Table 2 in Section V.D., following the Investment Process goal discussion, and for the most part, are not used in the performance assessment process (with the exception of one COV report as noted in Table 2). Information from evaluations is useful to programs to identify issues and opportunities for future investments.

A. OUTCOME GOALS AND RESULTS

The true value of NSF investments can only be measured by the outcomes identified over time. Outcomes might be the results of research or training sponsored by NSF, as long as 10 or 20 years ago. Therefore, NSF's Outcome Goals are very long-term goals, designed to ensure the progress of science and engineering, and to improve the future health, security, and quality of life for U.S. citizens. They focus on the results of NSF awards for research and education in science, mathematics, and engineering and are designed to promote the mission of NSF. The key strategy for success in achieving these goals is the use of rigorous merit review to make awards for activities that will influence research and education, both directly and indirectly, over the long-term.

Outcome Goals are expressed in a qualitative format. To determine the progress NSF makes in achieving these goals, the outputs and outcomes of NSF programs are judged qualitatively against the stated goals by groups of external evaluators known as Committees of Visitors (COVs) and advisory committees (ACs). More information about COVs and ACs is provided in Section III, "*Assessment and Evaluation Process*."

Following the discussion of each Outcome Goal, performance results reported in FY 2000 from awards made in earlier years are presented. These examples include only a few of the many noteworthy achievements reported by programs, Committees of Visitors and Advisory Committees in FY 2000. The examples are selected to cover the full range of activities supported by NSF and illustrate the impact and success of NSF programs and offer only a glimpse of NSF's broad range of supported activities. In each case a grant number issued by NSF can be used to identify the example for purposes of verification.

SUMMARY OF FY 2000 RESULTS FOR OUTCOME GOALS

External evaluators consistently judged NSF's programs to result in high quality outputs and outcomes. This result is a good indication that NSF's programs are achieving NSF's mission to promote the progress of science and engineering. Overall, agency results in this second year of GPRA reporting are similar to those obtained in FY 1999, and trends are beginning to appear. This is an important result, since a different subset of NSF's program portfolio is evaluated each year by different groups of external evaluators. This second year of reporting provides NSF with a good indication of areas needing attention and helps NSF to identify areas to focus on for future improvement.

External evaluators judging programs in FY 2000 indicate that NSF programs have successfully achieved Outcome Goals 1 and 2, and have achieved with limited success Outcome Goals 3 and 4.a – which we report as not achieved, although progress is being made. The two quantitative sub-goals of Outcome Goal 4 were achieved, as were the two sub-goals of Outcome Goal 5. We report six of the eight Outcome Goals as achieved in FY 2000. All Outcome Goals were achieved in FY 1999.

In FY 2000 evaluators identified the same areas in need of improvement as in FY 1999. Although many reports indicate improvement over FY 1999 performance in the area of diversity through increased participation of under-represented groups, some reports indicate that the numbers are acceptable but still lower than expected in order to have a significant impact. Evaluators comment that increasing participation of under-represented groups is an area needing more attention by NSF.

Other areas needing further improvement include (i) balance of portfolio by funding more high-risk[3] proposals; and (ii) use of both of NSF's merit review criteria by applicants and reviewers. Several reports note that there are clear indications that NSF Program Director use of the merit review criteria is evident in making decisions to fund or not fund proposals. Common issues identified in some reports that reduce program performance include increasing workload and delays in processing proposals.

In FY 2000 NSF limited options for grading to either ***successful*** *or* ***not successful****, and required clear justification for successful grades for qualitative measures. An outside accounting firm verified the goal achievement data tables for Outcome Goals 1, 2, 3,and 4.a.*

[3] "High-risk" research refers to proposals or projects that are judged to be at risk at achieving NSF goals or even producing significant breakthrough, and for which there is no scientific consensus or experience to judge the likelihood of success with any precision. Such proposals often provoke a wide range of opinions as to whether they should be funded or even submitted for consideration.

OUTCOME GOAL 1

DISCOVERIES AT AND ACROSS THE FRONTIER OF SCIENCE AND ENGINEERING

NSF supports cutting edge research in science, engineering, and education, that 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 that benefit society.

New knowledge – new ideas and theories, new tools and approaches – opens doors to understanding and solving problems and new paths for economic growth. The quest for discovery drives the imagination, creativity, and work of scientists and engineers. The innovation that results from discovery is a driving force for continued economic growth and an improved standard of living for all Americans.

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.

PERFORMANCE GOAL 1

NSF's performance toward this Outcome Goal is ***successful*** when NSF awards lead to:

- important discoveries;
- new knowledge and techniques, both expected and unexpected, within and across traditional disciplinary boundaries; and
- identification of high-potential links across these boundaries.

as judged by independent external experts.

PERFORMANCE INDICATORS

- importance and quality of discoveries, new ideas, new tools, and new technologies;
- interplay of disciplinary and interdisciplinary research; and
- balance of the portfolio.

BASELINE:
Pilot projects used FY 1997 and FY 1998 information and expert judgment in performance assessments that indicated NSF was successful in meeting this goal.

FY 1999 RESULT:

THIS GOAL WAS ACHIEVED.

FY 2000 RESULT:

THIS GOAL WAS ACHIEVED.

COMPARISON OF ACTUAL PERFORMANCE WITH PROJECTED PERFORMANCE

Approximately one-third of NSF's portfolio of programs was assessed by Committees of Visitors (COVs) for progress in achieving this Outcome Goal. (Section III, "*Assessment and Evaluation Process*," contains information on the process of evaluating NSF programs). For FY 2000, evaluators were asked to judge whether programs being evaluated were successful or not in meeting the goal.

In aggregating results for the agency, the reports of COVs and Advisory Committees were used, taking into account only those reports with substantive comments and ratings which were clearly justified. We find that all reports that provided a rating for this goal judged NSF successful in meeting this goal in FY 2000. Therefore, we report this goal as achieved.

External evaluators recognize that the highest impacts of discoveries are not identifiable in the short term. It may take 3–10 years for a research discovery to impact the private sector, and normally takes 15–20 years for fundamental ideas to find their way into everyday life.

Each year, NSF asks COVs to examine the portfolio of project support to identify activities they would characterize as high risk, multidisciplinary, or innovative, and to make an assessment of the overall scientific quality and balance with respect to these specific characteristics.

NSF identified "Balance of innovative, risky, interdisciplinary research" as an area of emphasis in FY 2000, and stated it as a goal in FY 1999. In FY 1999, of the COV reports that gave an opinion on balance of projects in the programs under review, most indicated that the balance was appropriate. For FY 2000, of the COV reports that gave an opinion on the balance, more than half indicated good balance, less than half indicated programs could fund more high-risk projects, and a few indicated they would like to see more innovative proposals.

COMPARISON: FY 1999 - FY 2000

This Outcome Goal was continued from FY 1999 with one modification. In FY 1999, the goal was stated using two levels of achievement: *successful* and *minimally effective*, with indicators for each level. Based on comments from COVs and ACs in FY 1999, NSF determined that the definitions for the *minimally effective* level of performance did not provide additional information in evaluating the programs.

In FY 2000, the indicators were refined to improve correspondence between information sought and information that can actually be collected, and the *minimally effective* standard was removed. A single definition for the *successful* standard is stated as the target level of performance for each Outcome Goal. In FY 2000, a stricter definition of allowed success was applied when reviewing reports of external evaluators, which required clear justification of ratings in reports.

The successful result in FY 2000 was also the finding by COVs and ACs in FY 1999. It is important to recognize that the evaluation was carried out on a different subset of NSF's portfolio and by a different group of external evaluators.

FY 2001 AND BEYOND

This goal will be incorporated under a new Outcome Goal heading for FY 2001, which rearranges NSF's five outcome goals into three broad Strategic Outcome areas: People, Ideas, and Tools. A table depicting the structural rearrangement is shown in Section VIII, *"Transition to FY 2001 and Beyond."* This improves the alignment of NSF's Outcome Goals with its mission and allows closer correlation between budget categories and NSF's Strategic Plan. This Outcome Goal will be combined with FY 2000 Outcome Goal 2 to become part of the Ideas Strategic Outcome area as described in the NSF FY 2001 Performance Plan.

EXAMPLES[4] OF FY 2000 ACHIEVEMENTS CITED BY EXTERNAL EVALUATORS

OUTCOME GOAL 1

DISCOVERIES AT AND ACROSS THE FRONTIER OF SCIENCE AND ENGINEERING

External evaluators cited the following examples of results from NSF awards as demonstrating success in support of Outcome Goal 1. These examples illustrate important discoveries, new knowledge and techniques, both expected and unexpected, within and across traditional boundaries, and high-potential links across these boundaries.

The examples also illustrate NSF-supported results reported in the FY 2000 areas of emphasis for this Outcome Goal. These areas include balance of innovative, risky, interdisciplinary research; new types of scientific databases and tools to use them; life in extreme environments; biocomplexity; and nanoscience and engineering. It is interesting to note that many results cross the boundaries between discoveries, new knowledge, interdisciplinary research, biocomplexity, and nanoscience. Where results are forthcoming, the diverse portfolios of awards show potential for significant impact in many of these areas.

- **MAPPING THE ARCTIC OCEAN FLOOR** A most impressive example of using innovative tools and, as a result, developing new databases, is the mapping of the Arctic Ocean floor using the nuclear submarine USS Hawkbill, and the Seafloor Characterization and Mapping Pods. The resulting data sets of high-resolution and narrow-beam bathymetry as well as chirp sub-bottom profiles will revolutionize Arctic Ocean modeling and have driven the development of advanced visualization techniques and multi-dimensional Geographic Information Systems. Sidescan images from the Lomonosov Ridge crest, collected during the Hawkbill mapping, show an ice scoured appearance marked by ploughmarks several kilometers long and several hundred meters wide. The ploughmarks are generally parallel, pointing to either the Barents Sea, or the Arlis Plateau area, as source regions of the ice. The parallel nature and size of the ploughmarks suggests grounding of a floating ice shelf rather than scouring of individual iceberg keels.

- **INTERDISCIPLINARY RESEARCH AT HOME** Most U.S. archaeologists study the Native American past, yet very few are Native Americans themselves. This has often created sharp disagreements between these two groups. To help bridge this gap the Society for American Archaeology has established a fellowship program that allows Native Americans to participate in both field and traditional academic settings. Although most will not become professionals in archaeology, the goal is to develop a cadre of individuals who can act as translators and mediators between two often divergent cultures. NSF funding has helped to increase the size and number of the fellowship awards.

[4] Additional examples may be found in Appendix XIV.

- **BENDING LIGHT AROUND CORNERS – IMPROVING TELECOMMUNICATIONS?** Telecommunication wavelengths are normally considered to be in the wavelength range where optical fiber has the lowest loss. Conventional single mode fibers have two low attenuation ranges, one about 1.3 micrometers, and another about 1.55 micrometers. Between these two ranges there is a high attenuation range, 1.35-1.45 micrometers, due to the presence of the OH radical. What's used in telecommunications also depends on the light sources and amplifiers available. NSF-supported researchers have created "omniguides" – or phototonic bandgaps using alternating concentric layers of polystyrene (plastic) and tellurium (a metal) having specified thickness. These "omniguides" cause complete internal reflection of photons, regardless of the direction of polarization of the light, and allows the guiding of light around sharp corners. Depending upon the tube diameter, the guides can be tuned over a wide range of wavelengths, for use anywhere from CO_2-laser (about 10 micrometers – one inch is 25,400 micrometers) to telecommunications wavelengths (between 1.3 and 1.55 micrometers). *Science* cited this discovery as one of its Top 10 "Breakthroughs of the Year."

- **QUANTUM CONTROL - QUANTUM OPTICS** Precise control and measurement of a variety of quantum systems were demonstrated that could have profound implications for nanoscale technology, chemical physics, and information science. The first completely quantum feedback scheme was developed, which followed the development of a scheme for the complete characterization of the quantum state of the internal degrees of freedom of atoms and molecules. Techniques developed for laser cooling of atoms led to the improvement of optical tweezers that are now capable of holding and moving individual molecules. An important example is the combination of techniques from biology, chemistry, and physics to manipulate single DNA molecules.

- **TOOLS TO BENEFIT MEDICAL APPLICATIONS** NSF-supported researchers have developed a needle-shaped accelerator tube that, when installed on a particle accelerator, can be used to deliver tumor-destroying neutron radiation directly to a tumor with minimum damage to healthy tissue. The prototype is undergoing engineering studies in preparation for studies on prostate tumor irradiation.

- **ADVANCING KNOWLEDGE - SHARED PROTEIN STRUCTURE DATABASE** With the tremendous increase in the amount of DNA sequence information now available, the opportunity exists to characterize the structure and function of all proteins. The support of a world-wide protein database was facilitated by NSF's long-term (~25 years) commitment to support a world-wide protein database developed by universities in cooperation with a national laboratory. The database is serving an international community of researchers (60% US, 30% European, 10% Japanese) interested in protein structure. X-ray coordinates are deposited into this database is then available to the scientific community world-wide. This NSF-sponsored protein database is the only one in the world and includes many features that will serve the advancing genome initiatives at NSF and other agencies in this country and throughout the world.

- **COMPUTATIONAL BIOLOGY** Research in molecular biology confronts many problems of high computational complexity. Large amounts of genomic data have been collected

that require high-speed algorithms for searching, analysis, and prediction of function. Pattern-matching methods developed by the theoretical computer science community were instrumental in expediting the sequencing of the human genome. New algorithms for generating phylogenetic trees are used in inferring evolutionary development of species. NSF-supported research in computational biology has contributed extensively to phylogenetic tree algorithms as well as biological sequence pattern-matching and the specific problem of finding repetitions in genomic data. Using NSF support, researchers developed a much more efficient algorithm for correlating diseases with genetic defects.

Life in Extreme Environments, begun as a focused investment theme in FY 1997, reflects an aspect of Biocomplexity in the Environment. NSF awards produced a wide variety of important discoveries in both the Arctic and Antarctic. Many discoveries concern regional environmental changes that have implications for global climate change.

- NSF interacts with several other federal agencies (Coast Guard, NASA, Army, Air Force, NOAA, USGS, and CIA) and is involved in interagency funding of many projects. Recent conclusions of a jointly-supported NSF and NASA research project have yielded new insights on a controversial subject, the evidence of possible life on early Mars. It was found that the carbonate minerals, one of the key components at the center of the controversy, originated through multiple inorganic processes rather than through biological processes, and that isotopes of iron record evidence of biological fractionation. As a result, iron isotopes can now be used as a new tool for recognizing potential evidence of life.

- In the Arctic, the international Surface Heat Budget of the Arctic (SHEBA) project demonstrated the increased importance of low clouds in warming the lower atmosphere and melting sea-ice The SHEBA Ocean project involved placement of the first-ever, year-long science program in the drifting Arctic ice pack. SHEBA was conducted from an icebreaker frozen in place 300 miles north of Prudhoe Bay, AK, but which drifted over 400 miles to a position 400 miles north of Barrow, AK. Upon arrival, scientists immediately confirmed that a major ice melting event in Summer, 1997, had thinned the ice pack and left thin ice conditions well into 1998. The cross-directorate, interagency (ONR, DOE, NASA, NOAA), and international (Japan, Canada) science project has collected a suite of ice, atmosphere, and ocean measurements to determine the environmental variables responsible for maintenance of the climatically important Arctic ice pack. The measurements address some of the most important unknowns required for improving computer simulations of climate change, weather predictions, and satellite retrievals.

- **EXTRASOLAR PLANETARY DISCOVERY** The first detection of a multiple-planet solar system outside our own has been widely interpreted as evidence that solar systems like ours may be fairly common companions to sun-like stars. A long-standing aim of many astrophysicists has been to detect and characterize sun-like pulsations in distant stars. The technology required to make such studies involves extremely precise measurements of the line-of-sight velocity or brightness of the target stars. It turns out that these measurements are precisely those needed to detect planets circling other stars. Seeking

to identify new extra-solar planets provided an exciting result in April: the discovery that three planets orbit the star Upsilon Andromedae, each with a mass comparable to the mass of Jupiter. The three planets are located at distances from their star that range from .05 to 2.5 astronomical units – one astronomical unit is the distance between the earth and the sun. This discovery was the result of a collaboration involving NSF-supported scientists at the Harvard-Smithsonian Center for Astrophysics and San Francisco State University, using the Anglo-Australian Telescope.

Biocomplexity represented a focused emphasis opportunity for NSF in FY 2000. However, NSF had made related investments in previous years and related investment outcomes underpin this FY 2000 emphasis area.

- **UNEXPECTED DISCOVERY** The structures of proteins that catalyze steps in metabolism and that orchestrate growth and development are specified by the genetic code in DNA. Quality control mechanisms exist at several levels to ensure that all proteins are produced exactly according to genetic instructions. The genetic code is translated into protein structural information through an intermediary called messenger RNA (mRNA), which is a transcript of the information in the gene. A quality control mechanism called RNA surveillance has recently been discovered that ensures that all mRNAs produce full-length functional proteins. RNA surveillance is accomplished by a mechanism that causes the rapid destruction of mRNAs that have mistakes in them that prevent their coding of full-length proteins. NSF-supported research at the University of Wisconsin led to the discovery of a novel and unanticipated pathway for surveillance of aberrant mRNA molecules. Components of this pathway were identified in yeast using a clever genetic selection initially designed to identify factors that affect ribosomal frame shifting. Instead, a novel set of genes was identified that encodes components of a pathway that mediates turnover of mRNAs containing nonsense mutations. This discovery offers an explanation for the long-standing problem of how cells contend with toxic proteins resulting from translation mRNAs containing nonsense or frame shift mutations.

- **EVOLUTIONARY RELATIONSHIPS** A recent series of discoveries grew out of the field recovery and analysis of fossil dinosaurs, birds, and mammals from the Gobi Desert. The expeditions recovered a wealth of fossil material. Analysis of this matrix showed, among other things, that birds had a complex origin from therapod dinosaurs. The large data base gathered, in part, with support from NSF is important not only to the understanding of animal life in the Gobi Desert, but to the understanding of the evolution of vertebrates worldwide.

- **PLANT GROWTH AND DEVELOPMENT** Studies of basic plant developmental mechanisms include studies of the molecular genetics of plant cells and tissues that lead to root and root hair development. The plant root and root hair allows the plant to absorb or restrict nutrients that are present in the soil environment. The success of studies of this sort sheds additional information on root uptake mechanisms to allow for future work on varying nutrient uptake and sequestration by the plant. The development of the shoot and root apical cells and tissues is considered the "holy grail" of plant developmental biology because these two structures give rise to all above and below

ground parts of all plants. Several NSF-supported research groups have lead the field in identifying genes that are necessary to initiate these cells and tissues during embryo development as well as maintain their organization throughout the growth of the plants.

Nanoscience and engineering represented a focused investment emphasis for NSF in FY 2000, an emphasis that builds upon the following discoveries and others like them.

- The development of sophisticated nanoscale optical measurement techniques that are broadly useful for the study of very fast dynamics in excited atoms, chemical reactions, carrier motions in semiconductors, and nanoelectronic devices is resulting from a breakthrough in stable short-wavelength, short time- duration lasers. The innovative work of NSF supported researchers has appeared in *Science* 280, 1412 (1998) and *Nature* 406, 164 (2000). One NSF-supported researcher was recently recognized by the John D. & Catherine T. MacArthur Foundation Award for 2000.

- NSF support has led to new understanding of manufacturing processes and equipment that hold great promise for the future. As the size of all kinds of electromechanical devices becomes smaller and smaller, accurate measuring devices are needed to enable manufacturing and ensure product quality. NSF-supported researchers have:

  - Collaborated to develop the world's highest-resolution and highest-accuracy magnetic suspension positioners. These positioners have been used to demonstrate the principles of ultra-precision positioners for semiconductor processing and advanced imaging systems.

  - Made discoveries leading to two key rapid prototyping technologies - selective laser sintering and 3D printing, respectively. These projects addressed fundamental interdisciplinary research issues in materials science and manufacturing processes. NSF support provided since the late 1980's has played a huge role in the evolution of rapid prototyping from an emerging technology to the mature field with commercial applications that it is today.

  - Studied precision engineering for high-quality products has resulted in major findings in grinding and metrology, both important for traditional manufacturing processes.

- Nanoscale molecular engineering of surfaces has been achieved by NSF-funded investigators in their creation of molecular corrals a few hundred angstroms in diameter and only one molecular layer deep. These molecular corrals have potential to serve as containers wherein a variety of biologically active chemical receptors could be anchored, providing a new basis for future sensor design and application. Other advances in nanoscale design and supramolecular self-assembly are bringing the diverse fields of synthetic and analytical chemistry, physics, materials science, mathematics, and information technology together. For example, families of mechanically interlocked molecules called rotaxanes and catenanes form the architectural foundation of a nanoscale machine that can be switched from one state to another - representing a molecular logic gate. These molecular logic gates are being used in ongoing efforts to design prototype molecular computers.

OUTCOME GOAL 2

CONNECTIONS BETWEEN DISCOVERIES AND THEIR USE IN SERVICE TO SOCIETY

In a world that is increasingly technologically driven, America's national security, economic competitiveness, health, environment, and quality of life depend on taking advantage of discovery. Linking advances in science and engineering with their potential uses generates a productive exchange of knowledge, information, and technologies. These linkages accelerate innovation, often yielding new insights into the underlying research. NSF views public accessibility of NSF-supported results as critical components for the progress of science and technological innovation.

NSF's role in addressing the use of discovery in service to society is in making sure that the channels of communication are open, that results are accessible to potential users, that NSF researchers are alert to how the results of their investigations might be of value to others, and that NSF's investment portfolio appropriately supports national priorities.

An important result of NSF-sponsored research is the generation and dissemination of data and information that can be used by others to explore theories and issues of importance to them. Federal funds are significantly leveraged to produce many times the original investment made in research projects by making NSF-sponsored results available to a wide range of scholars. NSF requires that scholars archive their data and acknowledge NSF support. A cursory review of major journals indicates the large numbers of published articles that acknowledge NSF-sponsored data collections as their source of data.

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 have the potential for future service to society.

PERFORMANCE GOAL 2

NSF's performance toward this outcome goal 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

as judged by independent external evaluators.

PERFORMANCE INDICATORS

- outputs and outcomes of NSF awards are made available to and put to use by others; and
- NSF-sponsored activities demonstrate a role in stimulating innovation and policy development.

FY 1999 RESULT:

THIS GOAL WAS ACHIEVED.

BASELINE:
Pilot experiments using FY 1997 and FY 1998 information and expert judgment in performance assessment by external experts indicate NSF was successful in meeting this goal.

FY 2000 RESULT:

THIS GOAL WAS ACHIEVED.

COMPARISON OF ACTUAL PERFORMANCE WITH PROJECTED PERFORMANCE

COVs were asked to judge whether the programs being evaluated were successful or not in meeting the FY 2000 performance goal for this Outcome Goal. Programs evaluated in FY 2000 were judged successful by experts in a significant majority of the reports. Several reports indicated that programs were successful in a limited context, a few reports indicated that programs were not fully successful, and a few reports did not provide judgements. Issues identified in FY 2000 are similar to those reported in FY 1999.

For those programs rated not fully successful, one was found to have awards that limited the scope and duration of the activity. Hence, connections between discoveries and service to society were not described in reports although some proposals had promised such connections. One report found the programs under review to be generally successful, but noted that room for improving the delivery of scientific research results to society, or more specifically to end-user communities, could be made. Another program not fully successful is described as funding primarily "basic" science, and hence it was left to others to make applications to society. Finally, one program was found to be producing results that have benefited a small community of users, including students and educators, and is showing promise for a much wider applicability, but insufficient time has elapsed for the products of this program to have penetrated into the potential broad user community.

We find, from aggregating the results of all reports which rated this goal, and using only reports with substantive comments and ratings which were clearly justified, that the majority of reports from external evaluators indicate that most NSF programs evaluated were successful in meeting this goal in FY 2000. Therefore, this goal was determined to have been achieved in the aggregate. However, as was noted in FY 1999, there is room for improvement in some programs. For those activities that were not judged fully successful, increased award size and duration are recommended by evaluators. NSF is emphasizing award size and duration as explicit management goals in FY 2001.

COMPARISON: FY 1999 - FY 2000

This goal was continued from FY 1999, with some modification of indicators to improve the correlation between information available and the intent of the goal. In FY 1999, the goal was stated using two levels of achievement: *successful* and *minimally effective*, with indicators for each level. Based on comments from COVs and ACs, it was determined that the definitions for the *minimally effective* level of performance did not provide additional information in evaluating the programs.

NSF works toward this outcome goal by using 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.

In FY 2000, a single definition for the *successful* standard was used as the target level of performance. A stricter definition of allowed success was applied that required clear justification of ratings in reports. The overall result in FY 2000 identified issues similar to those identified in FY 1999, even though the evaluation was carried out on a different subset of NSF's portfolio, and by a different group of external experts.

FY 2001 AND BEYOND

NSF can conduct outreach and awareness efforts, thus encouraging efforts toward connections but, generally, cannot mandate connections for all awards. NSF communicates the importance of its Outcome Goals, investment strategies, and expectations for the set of awards to the science and engineering community. Staff outreach efforts are emphasized for activities with strong potential to serve society. Regular reporting requirements for all awards help program staff understand the outputs and outcomes of their award portfolio and provide the context for decisions on new awards. Many investigators do not think about the possible connections their work might have in serving society. Many potential users are not aware of results from NSF awards that could be useful to them.

This Outcome Goal will be incorporated under a new Strategic Outcome Goal heading for FY 2001 which rearranges NSF's five Outcome Goals into three broad strategic Outcome areas: People, Ideas, and Tools. A table depicting the new organization is shown in Section VIII of this report, "*Transition to FY 2001 and Beyond*." The change to People, Ideas and Tools improves the alignment of NSF's goals with its mission and allows closer correlation between budget categories and NSF's Strategic Plan. This Outcome Goal will be combined with FY 2000 Outcome Goal 1 to become part of the Ideas Strategic Outcome in FY 2001. Results obtained in FY 1999 and FY 2000 have led NSF to refine this goal and to identify ways to improve data/information collection to assess this goal.

FY 2000 EXAMPLES[5] OF ACHIEVEMENTS CITED BY EXTERNAL EVALUATORS

OUTCOME GOAL 2

CONNECTIONS BETWEEN DISCOVERIES AND THEIR USE IN SERVICE TO SOCIETY

External evaluators cited the following examples of results from NSF awards as demonstrating the criteria for success in support of Outcome Goal 2. These examples made the connections between discoveries and their use in society, were rapidly and readily available, and were used as appropriate in education, policy development, or by other federal agencies or the private sector.

The examples below are shown to illustrate the variety of results of NSF awards reported in FY 2000. A few examples also demonstrate results in areas of emphasis, which include elements of Information Technology Research (ITR), Global Change, Research on Learning and Education, Plant Genome Research, Urban Communities, and Science and Technology Centers - Integrative Partnerships. The diverse portfolio of FY 2000 awards promise significant impact in one or more of these areas.

- **UP-TO-DATE LOCAL WEATHER INFORMATION** The Auto-Nowcaster system, jointly sponsored by the Federal Aviation Administration, the Department of the Army, the National Weather Service, and NSF under the U.S. Weather Research Program, provides one-hour Nowcasts of thunderstorms and strong winds. Demonstrations of the Auto-Nowcaster system were held at weather forecast offices of the National Weather Service, the Army Forecast Office, and the Aviation Weather Center. The demonstrations were highly successful the products are extensively used by operational personnel. The Sterling Virginia National Weather Forecast Office's severe storm warnings for 1998 were far more accurate than any previous year, and they give partial credit to the Auto-Nowcaster system for the improvement.

- **ANTICIPATING POWER SHORTAGES** Research sponsored by NSF has catalyzed interaction between government, academe and industry to achieve breakthroughs with immediate and lasting impact on society. In a multi-university center effort, researchers have discovered new methods to anticipate "brownouts" in electric power systems. Software has been developed to quickly assess the transfer capability and operational margins of electric power systems, and software is currently being implemented in electric utilities. Seven of the participating researchers were appointed by the Secretary of Energy to study last summer's blackouts and they were asked to make recommendations about the federal role in reducing future failures.

- **IMPACTING TELECOMMUNICATIONS** A microphone-array technology developed with ten years of NSF support has demonstrated both high-quality sound pick-up and the ability to identify and direct a camera to the speaker in a group of up to five people in a room. The sound quality achievable is comparable with face-to-face sound quality.

[5] Additional examples may be found in Appendix XIV.

Scientific advances underlying these capabilities include the development of new beam-forming algorithms, advanced hardware for real-time processing of multiple microphone inputs, and fast location algorithms. As a result of these breakthroughs, a major teleconferencing company has licensed the technology, and will develop a commercial product based on their prototype.

- **A BETTER LOOK ON LIFE** Biological instrumentation and instrument development as well as training programs at the undergraduate, graduate and postdoctoral levels have led to invention of the confocal microscope and, more recently, the development of both "two photon" and "near-field scanning optical" microscopes. Because of these developments, confocal microscopy has become a standard component of laboratory instrumentation important to the area of cell biology. Advances in cell biology have, in turn, resulted in a better understanding of the basic biological processes in plants and animals. Using the microscopy now available through NSF funding, the private sector has commercialized high-technology products that have been marketed both in the U.S. and abroad. The development of the two-photon microscope allows one to optically section cells, to follow the dynamics of intracellular movements in living cells, and to reconstruct the three dimensional structure of cells at different stages of development or in response to environmental signals. This instrument has revolutionized how scientists in all areas of cell biology view and study cell function. This microscope was commercialized, and is in great demand by the scientific community.

- **IMPACT ON INDUSTRIAL/AGRICULTURAL PRODUCTIVITY** Methodologies that facilitate higher yields and better selectivities for chemical processes, and that systematically optimize the performance and integration of chemical processes, are important for maintaining and enhancing global competitiveness and lead to a large positive balance of payments in the chemical industry. NSF research projects aim at improvement of processes with potentially large economic gains.
  - NSF-supported studies of the fundamentals of "thermal switch membranes" have had important results. The membranes are made from polymers with long side chains that crystallize. Switching membranes have been designed that open or close to particular molecules depending on temperature. This characteristic has been exploited to form coatings on seeds to control germination by blocking moisture permeation at low temperatures. This leads to a savings in seed costs and improvements in crop yields.
  - The reuse of materials in the semiconductor industry is critically important in controlling both cost and environmental impact. NSF supported engineering researchers in collaboration with the Semiconductor Research Corporation (SRC) have developed reactive membrane technology for removing trace impurities from gases and treatment systems for the production and recycle of ultra-pure water using photoactive catalysts. Four patents have resulted from the work, and members were recently recognized for their leadership by the Landmark Innovation Award.

This research area has vast potential implications for smart networks, wireless networking and telecommunications, speech and image processing, access and retrieval of data, and processing of sensor data.

- **CHECKING SYSTEMS SPECIFICATIONS** Nearly twenty years of NSF support has resulted in major contributions in the mathematical foundations for verifying the correctness of hardware and software. An NSF-supported researcher was a co-recipient of the Association for Computing Machinery Kanellakis Award in 1999 for the development of Symbolic Model Checking. Symbolic Model Checking is the most successful method yet devised for formally verifying that hardware and software systems meet their specifications. It has successfully uncovered subtle errors in hardware systems (such as dividers) and software systems (such as networking protocols) that extensive simulation failed to identify, and has been adapted by such companies as Intel, Motorola, IBM, and Siemens.

- **CORRECTING FOR DATA LOST IN TRANSMISSION** One of the basic building blocks of most communications over the Internet is known as transmission control protocol, or TCP. In spite of its ubiquity, TCP has been poorly understood. NSF-supported researchers have developed a simple mathematical model for predicting TCP performance This model shows that transmission behavior is not what was expected. This work is having a significant impact on the continuing evolution of TCP and the design of new transport mechanisms. It also shows substantial benefit in the use of forward error correction (FEC) in the delivery of large data files between a single sender and many receivers. FEC provides a way to correct for data that is lost in transmission. One consequence of this work is that most multicast transport mechanisms now rely on the use of FEC. The researchers have been recognized with a prestigious award from the Institute of Electrical and Electronics Engineers (*IEEE*) for this work.

By any criteria, NSF's support of the sequencing of the first plant genome is an impressive example of how a high-quality research resource can be generated, maintained, and made available worldwide. This sequencing effort, started in 1996, was coordinated through the *Arabidopsis* Genome Initiative (AGI) and an international consortium with two European and one Japanese laboratory.

- ***Arabidopsis* Genome** Completion of the *Arabidopsis* genome sequence at the end of 2000 was a truly remarkable achievement. Work with this model plant, *Arabidopsis*, has led to a detailed understanding of the molecular and genetic control of flower development. Initial conclusions have generated great excitement in the science community since it appears there is significant evolutionary variation in the mechanism of flower patterning, and some of these variations may explain the variation seen in flower morphology in nature. Not only will this information be useful to researchers in public institutions and universities, it will be useful to the private sector as well. The sequence data will be used by biologists to compare and contrast the structure and function of similar protein domains across different kingdoms. To complement this research resource, a separately-funded project maintains an *Arabidopsis* Stock Center at Ohio State University. From here seed stocks are made available to the research community world-wide.

OUTCOME GOAL 3

A DIVERSE, GLOBALLY-ORIENTED WORKFORCE OF SCIENTISTS AND ENGINEERS

The competence and capabilities of the Nation's science and engineering workforce keep America at the forefront of innovation and technological progress. Because science and technology now drive economic growth and shape public policy, professionals trained in science and engineering are being called upon to fulfill an increasingly broad set of responsibilities. 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's future.

The nation's universities and colleges educate and train the professionals who make possible America's current competitive position. The characteristics of the workforce of scientists and engineers are highly dependent on the systems through which they are educated and trained. To remain a world leader a strong academic research and educational capability must be maintained.

NSF works to achieve this goal by making awards for research and education activities that are intended to influence the development of the science and engineering workforce and that increase the participation of under-represented groups. While NSF can influence these systems through the types of proposal solicitations generated and the types of awards made, the agency does not control them. NSF programs provide only a relatively small, but important, portion of the overall U.S. investment in the development of the science and engineering workforce of the future.

PERFORMANCE GOAL 3

NSF's performance toward this outcome is ***successful*** when:

- participants in NSF activities experience world-class professional practices in research and education, using modern technologies and incorporating international points of reference;
- academia, government, business, and industry recognize their quality; and
- the science and engineering workforce shows increased participation of under-represented groups.

NSF's success towards meeting this goal is judged by external independent experts.

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; and
- outcome data from longitudinal studies as available.

FY 1999 RESULT:

THIS GOAL WAS ACHIEVED (IN MOST PROGRAMS).

BASELINE

Preliminary efforts in FY 1997 and FY 1998 to pilot the use of expert judgment in performance assessment indicated NSF was successful in meeting this goal.

FY 2000 RESULT:

IN THE AGGREGATE, NSF WAS JUDGED SUCCESSFUL IN A LIMITED CONTEXT: THIS GOAL WAS NOT ACHIEVED BY ALL PROGRAMS ALTHOUGH IMPROVEMENT OVER FY 1999 PERFORMANCE WAS NOTED IN SOME REPORTS. PROGRAMS HAVING SPECIFIC RESPONSIBILITIES FOR THESE AREAS WERE JUDGED TO BE SUCCESSFUL.

COMPARISON OF ACTUAL PERFORMANCE WITH PROJECTED PERFORMANCE

As indicated by NSF's FY 2000 Performance Plan, exceptionally strong performance in this goal is characterized by external recognition of scientists or engineers who received NSF support during their training; and when the production of degree recipients in science, mathematics, and engineering increases markedly for under-represented groups.

NSF's performance toward this goal was judged successful in the aggregate by external experts in committee reports with respect to achieving a globally oriented workforce**,** but not fully successful with respect to achieving diversity or increasing participation of under-represented groups**.** Using only reports with substantive comments and ratings that were clearly justified for *both* areas, we find that overall, the majority of reports from external experts indicate that NSF was not successful in meeting *both* areas of this goal in FY 2000. However, programs specifically designed to increase diversity and those designed to achieve a globally-oriented workforce were judged to be successful.

In FY 2000, about 19 percent of competitively reviewed proposals were from female applicants. They received about 20 percent of the awards.

Some COV reports noted that improvements have been made in the past year. However, numbers of under-represented groups are still low and should be increased. One report notes that the programs reviewed in FY 1999 did not achieve this goal, but that programs assessed this year did achieve it.

The number of proposals from female applicants has increased by 18% since 1993, and the number of awards has increased by 32%.

From a sampling of reports which rated programs successful in a limited context, one report notes that despite excellent efforts to fund activities that increase diversity, there does not yet appear to have been an increased participation of under-represented groups in the scientific workforce. Reasons for this remain elusive and may include time lags between intervention and effect.

One report notes that while the funding rate for women is not statistically different from that for males, the number of female proposers is significantly less than the number of male proposers. Reports note that factors affecting improved performance in achieving this goal are not always evident.

In FY 2000, the number of awards to minority PIs increased by 14% over FY 1999, ... but this is still only about five percent of the total number of NSF awards.

One report states that although NSF program officers work to involve under-represented individuals in the range of NSF activities, increased effort is needed, possibly through involvement of individuals from undergraduate institutions. One report notes that recruitment efforts for minority students have had only limited success. Other report recommendations include recruiting young scientists into the field, and in order to reduce attrition rates, nurturing them once they have started. Another report indicates the participation of under-represented groups in the workforce is low and slowly increasing, but that it is not possible to make an unequivocal assessment of the impact of NSF programs. One report states that a full evaluation of progress toward this goal cannot be determined in a three year period, although it rates the programs being evaluated as successful.

Experts agree that the current workforce does not meet national needs. They also agree that NSF programs on the whole are successful, but may not be sufficient to meet the national challenge. Changes in American society may be necessary to bring about the desired change.

COMPARISON FY 1999 – FY 2000

This goal was continued from FY 1999, with some modification of indicators made in FY 2000 to improve the correlation between information available and the intent of the goal.

In FY 1999, the goal was stated using two levels of achievement: *successful* and *minimally effective*, with definitions for each level of performance. In FY 1999, programs judged by external evaluators were rated successful in achieving all or most aspects of this goal in most reports. Several reports qualified their ratings by indicating that NSF should do more in the area of showing increased participation of under-represented groups. Based on comments from COVs and ACs in FY 1999, it was determined that the definitions for the *minimally effective* level of performance did not provide additional information in evaluating the programs.

For FY 2000, the indicators were refined to improve correspondence between information sought and information that can actually be collected. A single definition for the *successful* standard was used as the target level of performance. A stricter definition of success was applied when aggregating results, which required clear justification of ratings in reports. As a result of using stricter definitions of success, we have reported this goal as "not achieved" in the aggregate for FY 2000 as opposed to "achieved" in FY 1999. However, we note that many reviewers comment that NSF is making serious efforts to increase participation of individuals from under-represented groups, even though the numbers remain small.

STEPS TO MEET THIS GOAL IN THE FUTURE

Evaluating the impact of NSF support in achieving diversity or increasing the participation of under-represented groups is a long-term ongoing challenge for NSF. Part of the challenge lies in a fundamental inability to collect adequate quantitative information that describes the diversity of NSF stakeholders, in order to enable tracking of results. NSF cannot mandate full reporting from participants in order to evaluate this goal, and must rely on voluntary reporting. Such reporting is often incomplete and inaccurate. NSF also relies upon the involvement of the institutions it supports to create opportunities for under-represented groups.

NSF works toward this outcome goal by using the merit review process to make awards for research and education activities that influence the development of the science and engineering workforce, both directly and indirectly.

In spite of these challenges, NSF remains fully committed to increasing diversity through the increased participation of under-represented groups in science and engineering. Thus this goal remains a primary long-term objective of the agency. Significant progress toward meeting this goal is not expected in the short term, and will only be realized with continued efforts and investments over many years.

FY 2001 AND BEYOND

This Outcome Goal will be incorporated under a new Strategic Outcome Goal heading for FY 2001 that rearranges NSF's five Outcome Goals into three broad Strategic Outcome areas: People, Ideas, and Tools. A table depicting the structural rearrangement is shown in Section VIII of this report, "*Transition to FY 2001 and Beyond*". This change improves the alignment of NSF's goal with it's mission and allows closer agreement between budget categories and NSF's Strategic Plan. This Outcome Goal will be restated to avoid mixing goal objectives and indicators, and is more fully developed under the People Strategic Outcome area in FY 2001. In addition, it will also be placed under a new category in FY 2001, described as "Broadening Participation". This is included under NSF's Investment Process Goals in the FY 2001 Performance Plan.

In FY 2001, NSF will focus on increasing the participation of individuals from under-represented groups in the merit review process and on increasing the diversity of the NSF staff. Some NSF organizational units have taken steps to develop a broader effort to increase diversity within their programs by developing new programs to increase diversity.

NSF encourages participation of students on international projects to enhance the global awareness of the science and engineering workforce.

In FY 2000, NSF organized a working group to review its increased diversity goals. This working group produced a plan to improve diversity within the agency and in the reviewer pool. NSF will maintain this goal, and will focus on achieving a diverse science and engineering workforce within its own ranks in order to establish a more diverse leadership. NSF will continue to review approaches for improved evaluation of the impact programs have in achieving increased participation of under-represented groups outside the agency. Current program announcements ask proposers to address how the activity they propose will impact diversity in the science and engineering workforce.

NSF provides a relatively small investment in the overall federal investment to develop the national science and engineering workforce. Achieving this Outcome Goal in the long-term implies a gradual change in process and philosophy of educating the scientific, engineering, and technological community. A commitment on the part of institutions and their faculties to enhance the diversity of the science and engineering workforce and to provide a broader range of educational opportunities is needed to meet this goal.

FY 2000 EXAMPLES[6] OF ACHIEVEMENTS CITED BY EXTERNAL EVALUATORS

OUTCOME GOAL 3

A DIVERSE, GLOBALLY-ORIENTED WORKFORCE OF SCIENTISTS AND ENGINEERS

External evaluators cited the following examples of results from NSF as demonstrating the criteria for success in support of Outcome Goal 3. Noteworthy examples taken from committee reports have also been selected to demonstrate results in FY 2000 areas of emphasis that include integrative research and education opportunities, and participation of under-represented groups in integrative research and education.

These examples have also been selected to show that participants in NSF activities experience world-class professional practices in research and education, using modern technologies and incorporating international points of reference; that academia, government, business, and industry recognize their quality; and that the science and engineering workforce has shown increased participation of under-represented groups. In some examples, the diverse portfolios of awards show potential for significant impact in many of these areas.

- **PROJECT LEARN** The Laboratory Experience in Atmospheric Research (LEARN) is a four-year teacher enhancement project targeted at 5th through 8th grade science teachers from rural schools in Colorado. LEARN is comprised of two major components: a summer workshop and 3 days of in-district training. Between October and April, LEARN staff, NSF-supported scientists and science educators from the Science Discovery Program at the University of Colorado traveled to rural regions and conducted three, full-day, hands-on training programs for up to 21 teachers in each region. The training days drew 299 teachers from eight rural regions. For the first day, Science Explorers, 142 teachers participated as a team with five of their students in a full day of hands-on activities. Additionally, 41 teachers from an urban district also participated in Science Explorers in conjunction with LEARN. This brought the total number of students in attendance to 915. The teachers returned to their classrooms with written curriculum, material kits, and very excited students to help them teach the content and activities to the rest of the class.

- **COMPUTATIONAL GEOMETRY** Two NSF-supported research groups at Smith College, an undergraduate women's college, conducted research with undergraduates in computational geometry. One group discovered a combinatorial structure that underlies all planar linkages (bar-and-joint frameworks), a wide class of mechanisms that play an important role in robotics. The other group released the first public program for finding the shortest paths on a polyhedral surface from one source point to all vertices that may be useful in medical applications (to flatten brain maps), robotics (for navigation over rough terrain), and manufacturing (to unfold 3D shapes for planar cutouts).

[6] Additional examples may be found in Appendix XIV.

- **MENTORING FOR SUCCESS** NSF supports activities designed to expand opportunities for women, minorities, and persons with disabilities in all areas including computer and information science and engineering. Among its most successful projects is the Distributed Mentor Project. A longitudinal evaluation by the Center of the University of Wisconsin shows the Distributed Mentor Project (DMP) to be successful at meeting its primary goal of increasing the number of women entering graduate school in computer science and engineering (CS&E). Using a Baccalaureate & Beyond study conducted in 1994 as a comparison, the best male CS&E graduates were 10 times more likely to enter graduate or professional school within one year of graduation than the best female CS&E graduates. The figure for men being 29.19% of graduates, for women being 2.53% of graduates. Of the DMP participants, over 50% were enrolled in graduate or professional school the year following their graduation. In both cases the surveys considered only graduates with GPA's greater than or equal to 3.5. In each of these past years, approximately twenty-five undergraduate women have participated in the research and mentoring activities of the DMP with resounding success.

- **TOOLS THAT ENABLE** A variety of new tools have been developed which enable the learning of science and mathematics by persons with disabilities. Included are:
  - A three-dimensional, tactile model of the periodic table with Braille labels;
  - Documented instructions for accessible chemistry laboratory assignments placed on the World-Wide-Web;
  - CD-ROM-based accessible interactive math instructional games; and
  - A prototype graphical calculator for blind students using a force-feedback mouse.

- **ENGAGING DIVERSITY** An example of an approach to engage diverse students with differing scientific and technological ideas and techniques is used by a center in microelectronics that with collaborators from industry and in cooperation with the Semiconductor Industry Association. The center prepared 100 teaching models in 19 clusters using virtual reality and CD-ROM interactive teaching. It has seen a 50% increase in Hispanic population participation.

- **ENABLING THE DISADVANTAGED** An international project has enabled U.S. students from economically disadvantaged backgrounds and from under-represented groups to participate in an Organization of Tropical Studies (OTS) ecology course in Costa Rica. The students were exposed to hands-on, field-oriented research, and the international experience was a first for many of them. While some of the students had no prior familiarity with scientific research outside of a laboratory, and some were initially tentative about exploring the tropical forest and engaging in hands-on research, by the end of the course they had not only learned from their experience but also felt that the course was academically enriching and had provided an opportunity for personal growth.

OUTCOME GOAL 4

IMPROVED ACHIEVEMENT IN MATHEMATICS AND SCIENCE SKILLS NEEDED BY ALL AMERICANS

Proficiency in essential skills such as reading, and the understanding of basic concepts in mathematics and science, will be critical to the earning power of individuals and to the nation's economic competitiveness and quality of life in the 21st century. NSF is the only agency that directly aims at developing such proficiencies at all levels of education. Our activities set the stage for improved education in science and mathematics, both formal and informal, and lead to improved achievement in essential skills on the part of all Americans over time.

Achievement in mathematics and science skills is most directly dependent on the educational systems, both formal and informal, that impart such skills to those who need them. NSF exerts influence on these systems through support of new models for education, teacher preparation and enhancement, development of instructional materials and learning technologies, and support for standards-based education at all levels. But it is the educational systems – the schools, academic institutions, museums, and other organizations that comprise them – that are the implementers. The political constraints and budget stringency's they face will have an impact on their implementation that NSF can neither predict nor control. NSF programs influence educational systems and the public that supports them, but are only one influence among many.

The FY 2000 government-wide performance plan contains a performance goal that is 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 reliance on broad partnerships and development of comprehensive goals, solutions, and actions.

Two quantitative subgoals (4.b and 4.c) are included as areas of emphasis for this Outcome Goal. Both subgoals are continued from FY 1999 and will be maintained in FY 2001.

PERFORMANCE GOAL 4.a

NSF's performance toward this outcome goal is ***successful*** if 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.

NSF's success towards meeting this goal is judged by external independent experts.

PERFORMANCE INDICATORS

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

FY 1999 RESULT:

THIS GOAL WAS ACHIEVED.

BASELINE

Preliminary efforts in FY 1997 and FY 1998 to pilot the use of expert judgement in performance assessment either did not address this performance goal or did so in the context of a small base of program activity.

FY 2000 RESULT:

IN THE AGGREGATE, NSF WAS JUDGED SUCCESSFUL IN A LIMITED CONTEXT: THIS GOAL WAS NOT FULLY ACHIEVED OVERALL BUT NSF WAS SUCCESSFUL WHERE PROGRAMS HAD CLEAR OBJECTIVES DIRECTED TOWARD THIS GOAL.

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) and improve student achievement on a selected battery of tests, after three years of NSF support.

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.

FY 1999 RESULT:

THIS GOAL WAS ACHIEVED.

In FY 2000:

- Three major systemic initiatives implemented mathematics and science standards-based curricula in over 80% of the 7,630 participating schools.
- The systemic initiatives furthered professional mathematics and science development in over 90% of 7,630 participating schools.
- The systemic initiatives reported improved student achievement in mathematics in 81% of the 4,187 schools and improved student performance in science in 86% of the 2,474 schools using the same assessments for the last three years.

FY 2000 RESULT:

THIS GOAL WAS ACHIEVED.

PERFORMANCE GOAL 4.C

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

FY 1999 RESULT:

THIS GOAL WAS ACHIEVED.

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 2000 RESULT:

THIS GOAL WAS ACHIEVED.

In FY 2000, NSF awards provided intensive professional development (60 hours or more) to a total of 89,723 teachers, exceeding the goal of 65,000 for the second year.

COMPARISON OF ACTUAL PERFORMANCE WITH PROJECTED PERFORMANCE

Activities important to achieving success toward this goal include systemic approaches, attention to teacher preparation and development, partnership with other agencies, digital libraries, graduate teaching fellows as content resources in K-12 schools, and developing a strong research base for use by practitioners.

NSF works toward this Outcome Goal by using the merit review process to make awards for research and education activities that influence math and science achievement, both directly and indirectly, and by funding proposals that show potential to improve achievement in mathematics and science skills.

In the aggregate, when this goal was a clear objective of the programs being evaluated and when there was sufficient information available to carry out the evaluation, most reports indicated NSF programs were successful in achieving this goal. However, external evaluators were uncertain how to assess performance where programs did not have funds directed to these objectives, resulting in an assessment of less than successful or no assessment in many reports.

In aggregating results and using reports with substantive comments and ratings which were clearly justified for each area, we find NSF's performance toward this goal was judged as successful or successful in a limited context by a majority of external evaluators, and therefore, we describe this result as *successful in a limited context*, and report it to be not fully achieved in the aggregate in FY 2000.

For FY 2000, evaluators were asked to judge whether programs being evaluated were successful or not in meeting the FY 2000 performance goal and indicators. In arriving at an aggregated assessment, it is very likely that programs with objectives focused primarily in the areas of this goal are more successful in meeting this goal for these indicators than is indicated by the FY 2000 result statement of "not achieved". However, there remains disagreement among external evaluators as to the overall success of meeting the broad Outcome Goal as it pertains to "***all*** Americans".

Many external evaluators view this goal as primarily relevant to NSF's educational activities, and therefore tended to rate it only when evaluating educational programs. A significant fraction of COV reports indicate that the goal was not met because this goal was not a priority objective for many programs. Many reports do not rate this goal because the experts stated that the goal did not apply to the programs and there was no information provided on which to evaluate performance. Several reports give no comment at all.

For those reports which gave ratings of "not successful" the comments of experts indicate the reasons for lack of success are lack of relevance of this goal and that few of the awards are intended to focus on educational development; hence they do not contribute to the achievement of this goal. Those ratings are not automatically used in tabulating results overall. In one report covering several programs, the experts indicate that the programs were *minimally effective* in achieving the goal, and yet are able to cite examples of success relevant to achieving the goal. One report indicates that although they were aware of activities aimed to address this goal which could be evaluated, they could not locate data, and recommended that the staff summarize such efforts in the future.

In effect, many of the programs evaluated did not provide clear evidence of support for the objectives of this goal, external evaluators had difficulty in providing a qualitative assessment, and success across the agency is not apparent based on COV and AC reports. This goal is difficult to evaluate as it is written, in part because the specific activities referenced by the indicators are not widespread across all programs. NSF is reviewing the components of this goal for FY 2001 and FY 2002, to develop appropriate indicators more directly within the agency's control.

COMPARISON FY 1999 – FY 2000

This goal was continued from FY 1999, and includes two quantitative subgoals achieved this year and also in FY 1999. In FY 1999, this Outcome Goal was stated using two levels of achievement: *successful* and *minimally effective*, with indicators for each level. Based on comments from COVs and ACs in FY 1999, it was determined that the definitions for the *minimally effective* level of performance did not provide additional information in evaluating the programs.

In FY 2000, a single definition for the *successful* standard was used as the target level of performance, and a stricter definition of allowed success was applied, which required clear

justification of ratings in reports. The overall result in FY 2000 is similar to that obtained in FY 1999, even though the evaluation was carried out on a different subset of NSF's portfolio by a different group of external experts. In following stricter guidelines for definitions of success in FY 2000, we are reporting this goal as "not achieved", as opposed to "achieved" as we did in FY 1999.

STEPS TO MEET THIS GOAL IN THE FUTURE

Although NSF has a significant focused effort in mathematics and science education, NSF provides very little of the overall investment in K-12 education. Meeting the performance goal implies a commitment on the part of school districts, schools, and their faculty to modifying their approaches to education in order to enhance achievement; it is also very dependent upon the availability of resources to do so.

Results obtained in FY 1999 and FY 2000 have led NSF to refine this goal and to identify ways to improve data/information collection to assess progress by tracking contributions in achieving this goal more effectively.

The goal and indicators will be modified to clarify applicability of this goal to programs being evaluated in FY 2001. The reporting template used by external evaluators to assess programs will be improved to gather better information on achievement of programs for which this goal is relevant in order to gain a better understanding of performance. COVs have recommended that some NSF programs develop plans to address this goal more fully in future years and some action has been taken.

FY 2001 AND BEYOND

This goal will be incorporated under a new Strategic Outcome Goal heading for FY 2001 which rearranges NSF's five Outcome Goals into three broad Strategic Outcome areas: People, Ideas, and Tools. A table depicting the structural rearrangement is shown in Section VIII of this report, "*Transition to FY 2001 and Beyond*." The quantitative subgoals will be maintained in FY 2001 as subgoals of the People Strategic Outcome Goal.

The change to People, Ideas and Tools improves alignment of NSF's goals with its mission and allows closer agreement between budget categories and NSF's Strategic Plan. This Outcome Goal will be restated to avoid mixing goal objectives, under the People Strategic Outcome area in FY 2001. It will also be contained under a new category in FY 2001, described as "Broadening Participation". This is included in the description of NSF's Investment Process Goals contained in the FY 2001 Performance Plan.

FY 2000 EXAMPLES[7] OF ACHIEVEMENTS CITED BY EXTERNAL EVALUATORS

OUTCOME GOAL 4

IMPROVED ACHIEVEMENT IN MATHEMATICS AND SCIENCE SKILLS NEEDED BY ALL AMERICANS

External evaluators cited the following examples of results from NSF awards as demonstrating the criteria for success for Outcome Goal 4. Noteworthy examples taken from committee reports have also been selected to demonstrate results in FY 2000 areas of emphasis, which include K-12 systemic activities; research on learning and education; graduate teaching fellows in K-12 education; and K-16 digital libraries.

These examples are also shown to illustrate how NSF awards have led 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. The diverse portfolios of awards show potential for significant impact in many of these areas. NSF considers many of the K-12/16 activities listed to be of interest to students to engage them at an early state in their education in science, mathematics and computer science. Early involvement is extremely important for retaining students in science and engineering.

- High Quality Instructional Materials for both teachers and students are benefiting from discoveries related to teacher and student learning. Professional development for teachers is now viewed as a continuing process that is tailored to the needs of the adult learner. The work of NSF-supported projects have shown that site administrators and parents must also be part of the professional development process.
  - The *Hands-on Universe* project empowers teachers to use research-quality astronomical tools (remote telescopes, and software) in their classrooms with students. Last year, students in Massachusetts discovered a new asteroid in the Kuiper Belt. The announcement of their discovery and its confirmation made news worldwide. Two years ago, a different group of students using these tools discovered a supernova.
  - *Pattern Exploration* seeks to integrate mathematics and science using the new ideas of fractal geometry. Materials used in this teacher enhancement project were derived from two previous NSF-funded projects and help teachers deepen their understanding as well as their ability to use hands-on materials and software with their students to make patterns in nature visible.

[7] Additional examples may be found in Appendix XIV.

- Results may come from large-scale national centers or close-to-home, small-scale experiments that enable teaching and learning of scientific and technological ideas. A few examples of results derived from advanced technological education projects include:
  - The use of computer animation to visualize magnetic and other fields of force, to assist student understanding of complex physical concepts;
  - Centers that create and serve as depositories and disseminating agents for best techniques in technician education and industry practice, and have engaged in ground-breaking biological, telecommunications, semiconductor and marine discoveries; and
  - The adaptation, by an undergraduate program, of a sophisticated university field-based course on watershed management for teacher certification in environmental studies.

Systemic reform projects have leveraged the products and expertise developed by NSF awardees.

- Over the first six years of the Chicago Urban Systemic Initiative (USI) the percentage of fourth grade students meeting Illinois State Standards in science increased from 46 to 66.

- For the San Antonio USI, the average scores of African-Americans in grade 4 on the Texas Assessment of Academic Skills increased by 32 percentage points over four years, and those of Hispanic students by 39 percentage points, compared to a 16 percentage point increase for Texas fourth-graders overall.

- In the New York City USI, students in grades 3-8 scoring at or above grade level in mathematics on the California Achievement Test improved from 49% to 63% over a five-year period.

- Noticeable gains on the Texas Assessment of Academic Skills (TAAS) were evidenced for students in classrooms of K-8 teachers who received one or more years of professional development through the Austin Collaborative for Mathematics Education. The most dramatic gains were made by African American, Hispanic and economically disadvantaged students, reducing the performance gap with majority students.

- Recent findings from research studies indicate that NSF-supported efforts are decreasing disparities in student achievement across socioeconomic levels and identifiable populations. An evaluation conducted by the Wisconsin Center for Educational Research, showed evidence in a preliminary analysis of National Assessment of Educational Progress (NAEP) data that grade 8 mathematics achievement by African American students in Statewide Systemic Initiatives (SSI) states improved and exceeded the achievement in non-SSI states from 1990 to 1996.

Research on Learning and Education was given high priority in the report of the President's Committee of Advisors in Science and Technology on the Use of Technology to Strengthen K- 12 Education in the United States (March 1997). NSF, in partnership with the Department of Education, has built on past investments in this area in FY 1999 and continued joint activities in FY 2000. The NSF portfolio of awards has led to the development of an extensive array of tools, models, products and practices that address the needs of all students.

- NSF awards have created tools and resources to increase the assessment of science and mathematics learning, provide evidence on the quality of professional development, and enhance the capacity of professional developers. For example, *TECH-STAT*: Teaching Statistics Grades 1-6, a statewide implementation project in North Carolina, has developed both professional development manuals for teachers and statistics modules for students. Professional development materials are designed around the use of performance assessments to inform and strengthen classroom instruction.

- Informal science education programs–through variety of media–reach over 150 million viewers yearly. For example, *The World We Create*, an exhibit at the Louisville Science Center, features 40 hands-on science activities and over 400 graphic panels highlighting science careers, inventors, and problem solving strategies. From 1997-2000, the exhibit and associated programs reached almost 1.5 million visitors, nearly one-third the population of the rural state of Kentucky.

- Projects for developing professional materials produce printed materials as a major item but now include materials that require use of video as well as regular and on-line computer technologies (e.g., CD-ROMs, listserve, other software). Some examples are:
  - *Telemonitoring*–An Online Model to Sustain Professional Development in Science, Math, and Technology for Grades K-12.
  - *Developing Mathematical Ideas, and Problem Solving in the Sciences*–An Innovative Software Approach (IMMEX), is introducing secondary teachers to techniques and analyses using software developed for medical schools to teach problem-solving and monitor student and class mastery of concepts.
  - *Science K-6–Investigating Classrooms* has developed a library of videotapes and supporting print materials to illustrate the effective application of the National Science Education Standards in K-6 classrooms.
  - Teaching modules distributed by the American Chemical Society to secondary schools. They range from teaching the chemistry used in the carbonated beverage industry to treating waste-water. The modules have been field tested in 21 states by 58 teachers with 2200 students.

OUTCOME GOAL 5

TIMELY AND RELEVANT INFORMATION ON THE NATIONAL AND INTERNATIONAL SCIENCE AND ENGINEERING ENTERPRISE

NSF's provision of information on the national and international science and engineering enterprise is a customer-oriented activity. The performance goals for this activity aim for improved quality through enhanced *timeliness* and enhanced attention to *data quality* measures.

NSF's role in providing information on the science and engineering enterprise is important to assessing the health of the science and engineering enterprise and to the development of appropriate national policies. One such assessment is the report of the National Science Board to Congress of indicators on the state of science and engineering in the United States. Also, a number of long-running series of data provide a detailed picture over time of trends in areas such as federal and private sector funding of research and development and the science and engineering workforce. Such information on the national science and engineering enterprise is complemented by parallel studies of patterns in other nations. The types of information required by policy makers change over time, and NSF must ensure that studies addressing new types of data are incorporated as needed.

In order to ensure that it efficiently provides meaningful information on the science and engineering enterprise, NSF consults with users of the information to determine their needs for effective policy development, modifying existing studies, or adding new ones where feasible. NSF maintains long-standing time series of information that permit users to discern trends. NSF enhances connections with organizations gathering information on science and technology in other countries. NSF expands the analysis of the impact of science and technology on America's economic progress and quality of life. NSF increases the efficiency and timeliness of the data gathering and reporting processes, and increases the accessibility of data to users.

This Outcome Goal is quantitative. The alternative form is not used for this goal and it is not assessed by COVs.

TIMELINESS

In a recent survey, a sample of the science and engineering policy community indicated that improving timeliness of data was a high priority for them. Data collected either refer to a specific date, such as salary as of April 15 or fall enrollment as of October 15, or to a period of time, such as a calendar or fiscal year. The reference date in the latter case is calculated as the last day in the period. The time between the reference date and the first public release of data

from each of eleven major surveys is calculated, and then an average is taken across all surveys over a two-year period. Data are maintained by the Science Resource Studies (SRS) Division.

Means for achieving success: Taking advantage of advances in information and communications technologies; and regular reporting of status to give ample time to take action to improve performance.

PERFORMANCE GOAL 5.a

Maintain FY 1999 gains in timeliness for an average of 486 days as the time interval between reference period and reporting of data.

PERFORMANCE INDICATORS

Average time interval between the reference period and reporting data from SRS surveys.

RESULT:

THIS GOAL WAS ACHIEVED.

	FY 1995-96	FY 1999-2000
Baseline	540 days	
Goal		486 days
Actual		461 days

DATA QUALITY

The value of information on the science and engineering enterprise is highly dependent on its ability to address issues of importance to those who seek to use it in making policy decisions. Measures of data quality help users determine the reliability of the information and the extent of likely variance introduced by sampling processes. This goal replaced a related FY 1999 performance goal which dealt with customer measures of relevance. Data quality is one factor in addressing relevance.

Means for achieving success: NSF staff developed a standard set of data quality measures that are now in place. Procedures were established to ensure that appropriate information is provided electronically for all surveys.

PERFORMANCE GOAL 5.b

Establish a standard set of data quality measures for reporting of Science Resources Studies (SRS) products. Prepare reports on these measures for all SRS surveys and publish them in electronic formats to inform users of SRS data quality.

PERFORMANCE INDICATORS

Data quality measures and their use in SRS products.

RESULT:

THIS GOAL WAS ACHIEVED.

BASELINE

This is a new effort to provide standard measures. Their absence has placed limits on the usefulness of surveys.

Data quality measures were developed by SRS after conducting a thorough review of the written data quality standards for surveys conducted by other statistical agencies such as the National Center for Education Statistics, the Energy Information Administration, and the National Center for Health Statistics. A general literature review was also conducted, especially of material developed by the Office of Management and Budget's Federal Committee on Statistical Methodology (OMB/FCSM). Based on this research and analysis, a relevant set of measures was chosen as the standard set of quality measures for SRS surveys.

DATA QUALITY MEASURES

a. SAMPLING VARIABILITY
b. COVERAGE
c. NON-RESPONSE
   (1) UNIT NON-RESPONSE
   (2) ITEM NON-RESPONSE
d. MEASUREMENT

A standard format for reporting the data quality measures was developed. For each on-going SRS survey, the information on data quality measures, critical for the user to know for proper use of the survey data, was organized into the standard reporting format. These data quality reports were placed on the SRS web site and linked to the other information available for each SRS survey (http://www.nsf.gov/sbe/srs/ssdr/start.htm).

FY 2001 AND BEYOND

This goal will not be continued in this form in FY 2000. The goal has been redefined for FY 2001 to reflect the requirements established under the NSF Act of 1950. For FY 2001, NSF's five Outcome Goals are rearranged into three broad Strategic Outcome areas: People, Ideas, and Tools. A table indicating the change is shown in Section VIII, "*Transition to FY 2001 and Beyond.*" The rearrangement into the three areas improves alignment of NSF's Outcome Goals with its mission and allows closer agreement between budget categories and NSF's Strategic Plan. This topic will be addressed by a new area described as the Tools Strategic Outcome area in FY 2001.

B. MANAGEMENT GOALS AND RESULTS

FOCUS ON MANAGEMENT

NSF's Management Goals address the Foundation's administrative, operational and policy objectives. Excellence in managing the agency's activities is the key to achieving successful performance for all of NSF's goals. NSF's six Management Goals for FY 2000 address three issues of high priority in the Foundation – staff training, staff diversity, and how well advanced technology is being incorporated into NSF business operations. Five are continuations of goals previously established, with more stringent performance indicators. The new Management Goal included this year is reflective of our desire to more fully integrate technology into the core activities of the Foundation. Four factors are especially critical to successful management at NSF:

CRITICAL FACTORS

- **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.**

These critical factors are used in developing annual performance goals in the following performance areas: electronic proposal submission and processing; staff diversity; technological capability of staff through training; Y2K compliance; and use of electronic systems for project reporting. Results for the Management Goals, most of which have quantitative measures, are prepared and reviewed by NSF staff. They are presented below by area of performance.

SUMMARY OF RESULTS FOR MANAGEMENT GOALS

Five of NSF's six Management Goals were achieved in FY 2000. Areas identified as showing improvement 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 electronic Project Reporting System for project reporting by awardees. The one Management Goal which was not achieved involves the technological capability to submit, review, and process proposals electronically. Complex issues in establishing protocols for electronic signature prevented this goal from being achieved. NSF piloted two models for electronic certification of proposals and is currently assessing which model will best serve the agency and its customers. NSF engaged an outside accounting firm to verify the data systems for most Management Goals.

PERFORMANCE AREA: ELECTRONIC PROPOSAL SUBMISSION

The research and education communities have worked with NSF staff to build FastLane, our Web-based interface with grantee institutions. Each FastLane module has gone through a phase of expanding use. The most complex use of FastLane is for the submission of full technical proposals. NSF is the only federal research agency currently receiving proposals electronically on a production basis. In fact, effective FY 2001, electronic proposal submission is required by NSF, except in special cases.

MANAGEMENT GOAL 1

In FY 2000, NSF will receive and process at least 60% of full proposal submissions electronically through FastLane.

PERFORMANCE INDICATOR

Percent of full proposal submissions received electronically through FastLane.

	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001
Baseline	4.4%	17%			
Goal			25%	60%	95%
Actual			44%	81%	

RESULT:

THIS GOAL WAS ACHIEVED.

FastLane is a collection of electronic system modules that allows all transactions and communications between NSF and its grantees to be facilitated via the Internet. Under development since 1994, FastLane plays a major role in NSF's goal of achieving a paperless environment by the end of FY 2001. This ambitious goal was continued from FY 1999, and based on real-time results was revised in FY 1999 and FY 2000. The goal will be continued in FY 2001, with the target level of performance increased based on expectations and actual performance in FY 1999 and FY 2000.

In FY 2000, a total of 25,160 proposals were received and processed through FastLane. This is 81% of the full proposal submissions, which totaled 30,932. The success of this goal can be attributed to an aggressive outreach strategy combined with the efforts of a *Helpdesk*, a staffing resource designed to provide external customers with assistance. More than 35,000 requests for assistance were received by the *Helpdesk*, of which approximately 90% were related to proposal preparation and submission.

In September 2000, the NSF Director issued Important Notice 126 to the presidents of universities and colleges and the heads of other NSF grantee institutions to reaffirm that effective October 1, 2000, specified transactions with NSF must be accomplished electronically

via use of the FastLane system. The Important Notice is posted on http://www.nsf.gov/pubs/2000/iin126/iin126.htm.

IMPLICATIONS FOR FY 2001

FastLane continues to be rapidly accepted among our external customers for proposal submission. A significant number of program initiatives required the submission of proposals in FastLane in FY 2000. Virtually all programs will require FastLane submissions in FY 2001.

For FY 2001, the goal is being raised to 95% of full proposal submission. This equates to full implementation, and is consistent with the requirement specified in Important Notice 126 (see above). This percentage recognizes that some universities, colleges, or persons with disabilities, may experience difficulties in transmission, and others may not have the technical capability to submit electronically to NSF.

PERFORMANCE AREA: ELECTRONIC PROPOSAL PROCESSING

Current NSF practice is to use paper processing to review and process proposals. NSF's goal is to move to full electronic processing eventually eliminating internal paper processes currently in use.

MANAGEMENT GOAL 2

By the end of FY 2000, NSF will have the technological capability of taking competitive proposals submitted electronically through the entire proposal and award/declination process without generating paper within NSF. This was a new goal in FY 2000.

PERFORMANCE INDICATOR

Technological capability for a paperless process.

RESULT:

THIS GOAL WAS NOT ACHIEVED.

In order to enhance operational efficiency, NSF instituted requirements for electronic submission of grant proposals. Upon receipt, proposals are distributed to the appropriate office for administrative processing and peer review. Recommendations are prepared by NSF staff, funding decisions are made and award/declination letters are prepared for the approximately 30,000 proposals submitted annually. Historically, NSF required paper submission once grant proposals were submitted electronically. Efforts to modernize this process have been underway for several years. The goal is to move to electronic processing for the entire internal review and award/decline process.

At the start of the year, only four functions within the peer review process were still paper-based, namely: communications between NSF and the peer reviewer; electronic panel review system; letters to principal investigators (PIs) with declined proposals; and release of review results to PIs. By the end of the year, the technological barriers to a completely paperless process were removed within NSF, except for one remaining issue, i.e., the electronic equivalent of a signature for funding approval by NSF.

IMPLICATIONS FOR FY 2001

Two electronic signature pilot projects were initiated during the FY 2000. The results are being evaluated in FY 2001 to determine which approach will best serve the agency and its customers. Technological, financial, and legal issues still need to be resolved before electronic signatures can be fully adopted. NSF will continue to address these issues in FY 2001. In addition, we will make use of the technological capabilities established in FY 2000 to initiate pilot projects that demonstrate the paperless review capability. The FY 2001 goal for NSF is to conduct 10 pilot paperless projects that manage the review process in an electronic environment.

PERFORMANCE AREA: STAFF DIVERSITY

In order to increase the diversity of the U.S. science and engineering workforce, it is particularly important that program officers at NSF exemplify that diversity. As might be expected from national workforce trends, the science and engineering staff at NSF show the highest levels of under-representation of women, minority groups under-represented in the science and engineering careers, and persons with disabilities. During FY 2000, NSF concentrated on increasing the number of applicants from under-represented groups in its science and engineering (S&E) job applicant pool. In the coming year, NSF will continue these efforts, but has changed the indicator and goal to be more measurable.

MANAGEMENT GOAL 3

In FY 2000, NSF will show an increase over 1997 in the total number of hires to Science and Engineering positions from under-represented groups. This was a new goal in FY 2000, based on a revised FY 1999 goal.

PERFORMANCE INDICATOR

Efforts to sufficiently attract applications from members of under-represented groups in order to increase the numbers hired.

BASELINE:

Of S&E hires in 1997, 16 were female and 15 were from under-represented minority groups.

RESULT:

THIS GOAL WAS ACHIEVED. OF THE 113 S&E EMPLOYEES HIRED IN FY 2000, 39 WERE FEMALE AND 19 WERE MINORITY.

In order to ensure that the United States maintains its world leadership role in science and technology, the Nation must maintain a first-class cadre of scientists, mathematicians, and engineers from all segments of society. NSF is committed to diversifying its staff of scientists and engineers both in permanent positions and in the important rotating scientist positions.

During FY 2000, NSF engaged in a number of activities to increase the numbers of minorities in the S&E staff. These activities included:

- Requiring a diversity recruitment plan from each directorate and requesting a year-end report on their activities;
- Advertising specific vacancies in minority-serving magazines, institutions and professional associations;

- Attending job fairs that attract minority and female participants; and
- Requiring written justifications from selecting officials regarding their outreach activities and selection process.

Additionally, hiring information is displayed on the NSF GPRA homepage to assist managers in addressing under-representation. This information includes demographics of the current S&E workforce, statistics on the availability of minorities and women in the S&E labor pool, and the numbers of hires from under-represented groups.

IMPLICATIONS FOR FY 2001

NSF will maintain this goal in FY 2001. In addition to increasing emphasis by the Director's office, NSF will increase its recruitment presence at major program workshops and seminars, target recruitment material towards under-represented groups, and create a registry for minorities interested in serving on NSF advisory committees and panels. These committees and panels serve as a major resource for recruiting visiting scientists and engineers for the Foundation. NSF management will continue to emphasize diversity hiring practices, diversity pool statistics will be stressed at management sessions, and merit promotions will be reviewed at the senior executive levels.

PERFORMANCE AREA: CAPABILITY IN USE OF ELECTRONIC PROPOSAL/AWARD JACKETS - FASTLANE TRAINING

Electronic communication is changing the character of work for support, administrative, and science and engineering staff. Everyone at NSF must have good computer skills and be able to master new ones on a continuing basis. Since so much of the Foundation's business will be done through FastLane in the future, our training goal for FY 1999 focused on that system and was revised for FY 2000. Once the technological capability is in place for managing the entire proposal and award/declination process electronically, we will need trained staff to implement these paperless processes. In order for NSF to successfully implement the FastLane system it is essential that staff be oriented and properly trained.

MANAGEMENT GOAL 4

By the end of FY 2000, all staff will receive an orientation to FastLane, and at least 80% of program and program support staff will receive practice in using its key modules.

PERFORMANCE INDICATOR

Proportion of relevant staff trained (Orientation or Training)

Orientation	FY 1999	FY 2000
Goal	100%	100%
Actual	80%	100%

Training	FY 1999	FY 2000
Goal	95%	80%
Actual	43%	90%

RESULT:

THIS GOAL WAS ACHIEVED.

By the end of FY 2000, 100% of NSF staff had received an orientation to FastLane and 90% of program and program support staff had received practice in using its key modules**.**

As the use of FastLane continues to grow, it is critical that all staff are oriented to FastLane and other electronic systems. Through a series of ongoing formal classes, extensive individual and group training, distribution of informational materials, and the persistent efforts of NSF staff, NSF achieved this goal this year.

By the end of FY 2000, all 1,239 staff members (100%) on-board as of July 1, 2000 received an orientation to FastLane. For program and program support staff, 698 of 777 (90%) received practice in using its key modules.

The formal FastLane training program, initiated in FY 1998, continued through FY 2000. Approximately 40 FastLane classes were conducted during the year, with announcements posted on the training bulletin board and on the internal electronic Announce channel. Based on user feedback, we are moving towards new electronic business classes. These are scheduled to begin in January 2001.

Training on request was also provided to organizational units. Users were allowed to take training at their workstations through on-line training services, and informational material on FastLane was developed and distributed to employees.

Throughout the year, training statistics were posted on the GPRA web page to help managers monitor their progress. In addition, the NSF Training System was modified to allow for the entry of short, no-cost training as a way of capturing some of the required training data. Data was provided to the directorates to ensure that the information in the system was accurate and to encourage divisions to schedule employees for training.

IMPLICATIONS FOR FY 2001

Because NSF relies on visiting scientist and engineer positions to maintain it's portfolio, staff turnover will remain high. Hence, FastLane orientation will continue to be an on-going process. Moreover, as existing modules are enhanced or new modules added, the curricula will be modified to ensure that staff stay current in the use of FastLane and other electronic systems. Additionally, we will continue our outreach efforts to increase the proficiency of PI's and grant administrators in using FastLane. Since existing staff have been fully trained and procedures have been put in place to ensure that new staff receive orientation and training, FastLane training will no longer be reported as a goal.

PERFORMANCE AREA: YEAR 2000 COMPLIANCE

In order to fully support its mission, NSF's information systems must be able to withstand the problems predicted for many systems at the turn of the century. Based on guidance from OMB, NSF developed and submitted a plan (May, 1997) for evaluating, correcting, and testing its systems. Quarterly updates showed that NSF was accomplishing its objectives.

MANAGEMENT GOAL 5

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

PERFORMANCE INDICATOR

Operation of systems.

All activities needed to address the Year 2000 problem were completed according to plan, on schedule and within budget. Due to inspection and modification of pre-existing information systems, NSF entered the year 2000 trouble free in regard to the operation of computer and other critical systems. This activity will no longer be reported as a goal.

RESULT:

THIS GOAL WAS ACHIEVED.

PERFORMANCE AREA: PROJECT REPORTING

Assessing results for NSF's Outcome Goals requires a more accessible database of project results than NSF has previously maintained. A new project reporting system was fully implemented at the start of FY 1999. During FY 2000, NSF continued to monitor the use of the system and the quality of the information gathered, and took appropriate steps to address problems, as they were identified.

MANAGEMENT GOAL 6

In FY 2000, at least 85% of all eligible project reports will be submitted through the new Project Reporting System.

PERFORMANCE INDICATOR

Percent of eligible project reports submitted through the new Project Reporting System.

Training	FY 1999	FY 2000
Baseline	59%	
Goal	70%	85%
Actual	59%	92%

RESULT:

THIS GOAL WAS ACHIEVED.

The Project Reporting System (PRS) is part of NSF's effort to use advanced technology to create a more efficient, paperless work environment, in which information is exchanged between the Foundation and its research and education customer community via the Internet. In its first two years of use, the PRS has provided a wealth of information that was previously not available electronically. This has lead to significant changes in how NSF responds to internal as well as external requests for information on the technical aspects of NSF awards.

An internal search utility allows NSF staff to search the reports based on a variety of criteria and isolate the award and/or report of interest. This is leading to profound changes in how NSF can respond to requests from Committee of Visitors, internal management, and the public on technical aspects of NSF awards.

During FY 2000, 8,949 final project reports were received, of which 8,269 (92.4%), were submitted through the PRS. The remaining 680 final project reports were submitted via paper or email.

In addition to final project reports, annual reports are submitted for those grants that are active. During FY 2000, 9,987 annual reports were submitted via FastLane. Information on annual project reports submitted via paper is not maintained in NSF's electronic systems, so data on annual reports is not included in this Management Goal. However, since annual and final project reports usually contain the same information and are submitted by the same Principal Investigators (PIs), we expect that the percentage of annual reports submitted through the PRS is comparable to the percentage of final reports.

Two NSF documents that provide guidance to applicants and institutions were revised to reference the new PRS: the NSF Grant Proposal Guide and the NSF Grant General Conditions. Both documents now reference the fact that PIs are required to submit reports electronically via the PRS in FastLane. Based on feedback received throughout the year, modifications to the PRS have been made. NSF will continue to enhance the system based on user feedback and policy changes, as resources allow.

In September 2000, the NSF Director issued Important Notice 126 to the presidents of universities and colleges and the heads of other NSF grantee institutions describing NSF's requirements for a paperless proposal and reporting system. The important notice is posted on http://www.nsf.gov/pubs/2000/iin126/iin126.htm.

IMPLICATIONS FOR FY 2001

During FY 2000, NSF received 92% of final project reports through the PRS. Recognizing that minor exceptions are allowed for older awards, this represents nearly full implementation. Since the PRS has been successfully implemented and is now fully utilized, project reporting will not be continued as a goal in the future. However, NSF will continue to emphasize the importance of using the PRS with our external community.

C. INVESTMENT PROCESS GOALS AND RESULTS

FOCUS ON INVESTMENT PROCESS

NSF's key strategy for success is the use of external merit review to make awards for activities that will impact research and education in mathematics, science, and engineering, both directly and indirectly. The heart of the investment process is competitive merit review by external peers, using two criteria established by the National Science Board. The scientists and engineers comprising NSF's program staff take NSF priorities and the advice of 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.

MEANS & STRATEGIES – CRITICAL FACTORS FOR SUCCESS

- 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 that guidance and 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.

SUMMARY OF RESULTS FOR INVESTMENT PROCESS GOALS

Seven of NSF's 15 Investment Process Goals were achieved in FY 2000, seven goals were not achieved, and one goal did not apply to projects during FY 2000. Areas needing improvement include the implementation of both Merit Review Criteria by reviewers and program officers; making new program announcements and solicitations available at least three months prior to the deadline or target date; decreasing the time to decision to six months or less for 70% of proposals; and maintaining openness in the system to increase the percentage of awards for new investigators to 30%. NSF engaged an outside accounting firm to verify the data systems for most Investment Process goals.

INVESTMENT PROCESS 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. Examples include use of merit review and improved practices such as the time it takes to process a proposal. In addition, the facilities oversight performance goals relevant to the federal science, space and technology agencies, are included in NSF's set of Investment Process Goals. Results for the Investment Process Goals, most of which have quantitative measures, are prepared and reviewed by NSF staff. Investment Process Goal 2 is a qualitative goal expressed in the alternative form and evaluated by external experts (COVs and ACs). Results are presented and discussed according to performance areas: Proposal and Award Processes, Customer Service, Maintaining Openness in the System, Integration of Research and Education, Diversity, and Facilities Oversight.

PERFORMANCE AREA: PROPOSAL AND AWARD PROCESSES - USE OF MERIT REVIEW

NSF policy states that each recommendation for funding or non-funding of a proposal must be accompanied by at least three external merit reviews and a balanced discussion of those reviews. The average total number of reviews per proposal ranges between 5 and 9. Merit review of proposals that takes into account the quality of the proposed project and the potential for broader impact, is a critical component of NSF's decision-making process for the funding of research and education projects. The Foundation strongly believes that award selection based on a competitive merit review process with peer evaluation ensures that ideas from the strongest researchers and educators are identified. For the more than 29,400 competitive proposal decisions made in FY 2000, more than 46,000 external reviewers reviewed one or more proposals by mail, and more than 8,700 reviewers served as panelists. NSF annually prepares a report on the NSF Merit Review System, which is reviewed by the National Science Board.

INVESTMENT PROCESS GOAL 1

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.

Based on NSF's original goal, which included merit reviewed projects as a percentage of all NSF funding, the Foundation exceeded its goal of 90% for FY 2000. As in FY 1999, NSF allocated 95% of its funds to merit-reviewed projects. This goal was achieved in FY 1999 and maintained in FY 2000. It will be revised based on OMB revised definitions for FY 2001.

RESULT:

THIS GOAL WAS ACHIEVED.

Percent of project funding subject to merit review	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001
Baseline	89%	90%			
Goal*			90%	90%	85%**
Actual*			95%	95%	

***N.B.** Based on old OMB definitions. During FY 2000, the Office of Management and Budget revised the federal goal, stating that 70-90% of research and development funds should be awarded to merit reviewed projects. Under the new definition, federally-funded research and development centers (FFRDCs) and merit-reviewed scientific research with competitive selection and internal (program) evaluation will not be considered merit-reviewed. Taking into account the new definition, NSF has revised its goal for FY 2001 to 85%.

*****Based on the most recent definitions from OMB, the revised percent of project funding subject to merit review is:***

FY 2000 Goal	**80% (est.)**
FY 2000 Result	**87%**

PERFORMANCE AREA: PROPOSAL AND AWARD PROCESSES - IMPLEMENTATION OF MERIT REVIEW CRITERIA

Implementation of the merit review criteria is an important goal in the proposal selection process and is critical for ensuring that the best projects are supported. In FY 1998 the National Science Board reviewed the NSF merit review criteria and established two revised criteria in accordance with the NSF Strategic Plan. The two merit review criteria, which took effect in early FY 1998, are designed to weigh a proposal's quality and broader impact relevant to NSF's goals through expert evaluation of the proposal's technical merit, creativity, educational impact, and potential benefits to society. The use of *both* criteria (quality and impact) by both expert reviewers and program staff is an important step in the NSF investment process to ensure realization of NSF's broader goals.

To evaluate NSF's progress in meeting this goal, external committees are asked to assess the use of the two merit review criteria by reviewers and program officers. The results of the assessment are described below using the alternative form (non-quantitative form) allowed by the Act. Results in FY 1999 identified issues which NSF began to address in FY 2000. Results in FY 2000 indicate that more attention is being given to use of both criteria. However, improvements are still needed.

INVESTMENT PROCESS GOAL 2

NSF's 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,

as judged by external independent experts.

PERFORMANCE INDICATOR

Use of merit review criteria by reviewers and program staff.

BASELINE:

New criteria went into effect in early FY 1999. External expert judgment is used to assess performance. The assessment process was used for the first time during FY 1999.

FY 1999 RESULT:

LARGELY SUCCESSFUL, NEEDS SOME IMPROVEMENT.

FY 2000 RESULT:

THIS GOAL WAS NOT ACHIEVED.

Full performance in achieving this goal requires that both merit review criteria be addressed by both reviewers and program staff. The results indicate that NSF was not fully successful as judged by external evaluators.

For FY 2000 COVs reviewed 78 NSF programs and were asked to judge whether the programs were successful or not in meeting this performance goal. A total of 58 out of 64 reports rated programs on their use of both merit review criteria. NSF was judged successful in achieving this goal in 20 of the 58 reports.

In most cases where NSF was not successful, reviewers did not fully address the second merit review criterion regarding the broader impacts of the proposed activity in their reviews or applicants did not address broader impacts in their proposals. Most COV assessments noted that NSF staff addressed both criteria in their decisions.

It is important to note that the two merit review criteria were not implemented until FY 1998, and the time period covered by COVs conducting program assessments in FY 2000 included proposals that had been reviewed before the two criteria were implemented (i.e., proposals from FY 1997). Since both criteria were not fully implemented during this time period, full use by reviewers and staff should not be expected for this assessment. The FY 2001 assessment will include proposals reviewed in FY 1998 and beyond, which will be the first assessment to review the full implementation of the two criteria. Full usage should become more apparent in the FY 2001 and FY 2002 assessments.

COMPARISON: FY 1999 – FY 2000

In FY 1999, this goal was stated using two levels of achievement: *successful* and *minimally effective*, with indicators for each level. In FY 1999, a majority of reports rated programs as successful on their use of the merit review criteria. In most cases where programs were not fully successful it was indicated that reviewers and proposers were not fully addressing both review criteria. Based on comments from evaluators in FY 1999, it was determined that the descriptors for the *minimally effective* level of performance did not provide additional information in evaluating the programs.

For FY 2000 a single descriptor for the *successful* standard was used as the target level of performance. In FY 2000 a stricter definition of allowed success was used in aggregating these results. This required clear justification of ratings in COV and AC reports. If reports gave successful ratings but did not mention use of both criteria by both reviewers and program managers, the goal was judged to be less than fully successful. It is possible that programs are more successful in achieving this goal than these results indicate. However, most reports indicate NSF programs can still improve on use of both criteria.

The issued identified by COVs in FY 2000 are similar to those observed in FY 1999, even though the evaluation was carried out on a different subset of NSF's portfolio by a different group of external experts. Comments from reports indicate that progress is being made. Nevertheless, improvement is still needed.

STEPS TO IMPROVE PERFORMANCE RESULTS FOR THIS GOAL FOR FY 2001 AND BEYOND

NSF took steps in FY 2000 to educate reviewers and proposers on the use of the merit review criteria. NSF clarified the meaning of the criteria and stressed the importance of using them. Improving results for this goal depends upon improving information in proposals submitted by proposers and on motivating reviewers to provide substantive comments on both criteria. It also depends on the use of both criteria by NSF staff when making decisions. NSF can encourage proposers and reviewers to address both criteria, but has limited control over their response. Many proposals do not contain sufficient information necessary for reviewers to evaluate the broader impact criterion. To improve this situation, NSF has modified program announcements to encourage proposers to provide information on all relevant aspects of the merit review criteria in their proposals. NSF has recently re-issued guidance to the proposers and reviewers, stressing the importance of using both criteria in the preparation and evaluation of proposals submitted to NSF.

To assist reviewers and staff in FY 2001, separate on-screen pages are available in FastLane - NSF's electronic data system. These provide the capability for reviewers to address each merit-review criterion separately. In FY 2001, performance data will be collected from the FastLane database.

Full implementation of this goal is a priority for NSF in FY 2001 and beyond. To do so requires information to be included in proposals, addressed by reviewers, and taken into account by program staff. NSF has taken steps to ensure that incoming proposals contain adequate information for reviewers to evaluate. NSF is taking steps to further implement this goal by developing a system to determine the extent of program officer use of both criteria in decision making. This process will be made quantitative upon determination of an appropriate mechanism and baseline.

In response to a directive by the Senate Appropriations Committee that NSF review the procedure and criteria for merit review once the new criteria had been in place for a year, in FY 2000, NSF issued a contract to the National Academy of Public Administration (NAPA). This contract was designed to conduct a study of the impact of the new merit review criteria on the nature of the projects NSF supports. In conducting the study, NAPA interviewed key personnel and stakeholders from the S&E community and analyzed a sample of COV reports and proposal documents. The key finding was that it is too soon to make valid judgements about the impact and effectiveness of the new criteria. The NAPA report also highlighted the need to (1) improve the conceptual clarity of the criteria, (2) better communicate with proposers, reviewers and NSF staff about how the criteria are to be used, and (3) improve quantitative measures and performance indicators to track the objectives and implementation of the new criteria. NSF will act upon these suggestions beginning in FY 2001.

This goal will be maintained and emphasized in FY 2001. It will appear as two goals, one addressing use of the criteria by reviewers, and a second addressing use of the criteria by NSF staff. Improvements to the COV and AC process and guidelines for evaluating this goal are being implemented in FY 2001.

PERFORMANCE AREA: CUSTOMER SERVICE - GENERAL

For the past two years NSF has participated along with about 30 other federal agencies in a national assessment of customer satisfaction. The mechanism used to assess customer satisfaction is the American Customer Satisfaction Index (ACSI), a cross-industry index of customer satisfaction. This survey is conducted by the University of Michigan. In FY 1999 the ACSI survey team interviewed a random sample (n=260) of NSF grant applicants which included both awardees and declinees. Approximately 68% of the applicants interviewed submitted proposals that were declined. This percentage is consistent with NSF's overall proposal funding rate.

The Foundation's ACSI results for the FY 1999 survey indicated that NSF grant applicants generally hold NSF in high regard and give it high marks for accessibility and usefulness of information. However, NSF received only mid-level scores for its merit review process and for its handling of customer complaints. NSF believes there is room for improvement in this area and identified several factors to be addressed in FY 2000. These include training staff and developing models of best practices.

Based on the FY 1999 survey, NSF elected to establish three new related goals in FY 2000. Two were achieved, one was not. These goals were intended to help identify areas where NSF could improve service to customers. The results obtained by setting these goals have helped NSF to identify areas of customer service that need improving, and NSF is making use of this information to set goals for FY 2001 and beyond. NSF will not continue Investment Process Goals 3, 4 or 5 beyond this year.

INVESTMENT PROCESS GOAL 3

Identify possible reasons for customer dissatisfaction with NSF's merit review system and with NSF's complaint system.

PERFORMANCE INDICATOR

Results of NSF applicant surveys.

RESULT:

THIS GOAL WAS ACHIEVED.

In FY 2000, NSF commissioned additional surveys including the ACSI survey of awardees and informal surveys and focus groups at NSF regional grants seminars. These were designed to identify the reasons for Principal Investigator dissatisfaction with the timeliness and efficiency of the proposal process, the quality and fairness of the merit review process, and the handling of customer complaints.

The 2000 ACSI survey indicated that NSF improved slightly in two key areas:

1. timeliness and efficiency of the proposal process; and
2. quality and fairness of merit review.

These were the two areas of greatest concern identified in the FY 1999 survey. NSF will continue to address customer service as noted in Investment Process Goals 3, 6, and 7.

INVESTMENT PROCESS GOAL 4

Identify best practices and training necessary for NSF staff to conduct merit review and answer questions about the review criteria and process. Identify best practices and training necessary for NSF staff to answer questions from the community and to deal with complaints in a forthright manner.

PERFORMANCE INDICATOR

Development of models of best practices and NSF staff training, where appropriate.

RESULT:

THIS GOAL WAS NOT ACHIEVED.

NSF conducted customer service surveys and solicited other forms of feedback in an effort to pinpoint specific customer issues and to identify effective practices for handling customer complaints within NSF. Further, other federal agencies were examined to locate a model with similar customer interactions, but no appropriate model was identified. Models of best practices and NSF staff training are still being developed in FY 2001. NSF continues to place great importance on these issues and will complete this effort in FY 2001. In addition, NSF will pilot the best of the models in NSF divisions and provide specific customer service training to NSF staff.

INVESTMENT PROCESS GOAL 5

Improve NSF's overall ACSI index compared to the FY 1999 index of 57 (on a scale of 0-100).

PERFORMANCE INDICATOR

Results of the American Customer Satisfaction Index (ACSI).

BASELINE:

57 on a scale of 0-100 in FY 1999

RESULT:

THIS GOAL WAS ACHIEVED. NSF ACHIEVED AN ACSI INDEX OF 58 IN FY 2000. THIS FEEDBACK IS HELPING NSF TO FOCUS ITS EFFORTS TO IMPROVE CUSTOMER SERVICE.

In addition, NSF coordinated a Customer Service Focus Group meeting in March 2000 as part of an NSF regional grants conference held at Louisiana State University. This Focus Group was a follow-up activity to an informal email survey of seminar participants conducted prior to the seminar. The participants were 32 Principal Investigators and research administrators. The primary topics addressed by the survey were NSF's handling of complaints and the timeliness and efficiency of the NSF proposal process. These informal surveys were continued at the Purdue University seminar in October 2000 to compare previous data and to gather additional information concerning customer service.

NSF arranged for another ACSI survey in FY 2000, involving only grantees, to ascertain possible reasons for customer dissatisfaction with the merit review system and with NSF's complaint system. This awardee survey was performed to confirm the results of the ACSI survey (see Investment Process Goal 5) and to get more detailed information on specific issues related to merit review and customer interaction. The University of Michigan conducted the supplementary survey of NSF awardees in November 2000 using a set of questions developed by the Foundation.

The results from the FY 2000 awardee survey indicate that NSF customers' primary concern regarding the timeliness and efficiency of the proposal process is the time it takes NSF to reach a funding decision.

NSF is striving to improve the time to decision (see Investment Process Goal 7). Applicants who stated that they had a specific problem or concern with the quality or fairness of merit review identified two primary concerns: reviews were inappropriate (i.e., reviews did not seem to adequately address the proposed project, in the opinion of the proposer) and reviews were uneven (i.e., the range of review scores included both high and low scores).

Finally, survey participants in FY 2000 who stated that they had complained to NSF described the nature of their complaints primarily in three ways: 1) concern about overall quality or fairness of proposal merit review process; 2) problem submitting a proposal, review, or project via FastLane; and 3) problem making timely contact with appropriate person at NSF.

PERFORMANCE AREA - CUSTOMER SERVICE: TIME TO PREPARE PROPOSALS

This customer service standard was established in response to a survey where NSF applicants revealed that having a minimum of three months (90 days) between program announcements and proposal deadlines was highly valued. NSF staff work toward this goal by limiting the number of special competitions requiring individual program announcements and solicitations, planning for such competitions as far in advance as possible, and initiating clearance processes at least six months prior to the anticipated proposal deadlines. Significant improvement has been made toward achieving this goal since last year. NSF will maintain the target level in FY 2001.

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.

INVESTMENT PROCESS GOAL 6

Ninety-five percent of program announcements and solicitations will be available at least three months prior to proposal deadlines or target dates.

PERFORMANCE INDICATOR

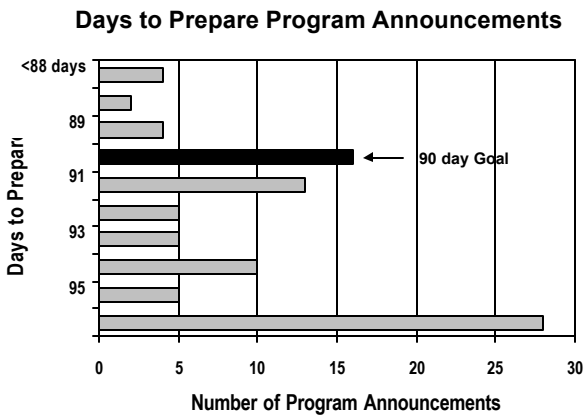
Percent of program announcements and solicitations available at least three months prior to proposal deadlines or target dates.

	FY 1998	FY 1999	FY 2000	FY 2001
Baseline	66%			
Goal		95%	95%	95%
Actual		75%	89%	

RESULT:

THIS GOAL WAS NOT ACHIEVED.

In FY 2000 89% of program announcements and solicitations were made available at least three months prior to their deadline/target date. Approximately 97% of program announcements and solicitations were available within 5 days of the three-month goal. This is a significant improvement over FY 1999, when 75% of announcements met the 3-month standard. The following bar-chart visually demonstrates the number of program announcements that gave applicants 90 days or more to prepare proposals (goal achieved) compared with those that missed the goal by a few days. Ninty-five percent of announcements were posted within 5 days of the three month goal.



The most common reason cited for not achieving this goal was delay in posting announcements on the NSF web site. In FY 2000 a web-based system for creating program announcements was established. This system has decreased the time required for an announcement to be posted on the NSF web site. This should aid the agency in achieving this goal. However, this was the first year of implementation, and not all announcements were prepared using the new system. The Foundation intends to review and revise the timing of clearance procedures, in order to ensure that web posting of announcements will occur in a timely manner. NSF is also working to enhance the tracking system that measures the time available to applicants to prepare proposals in an effort to improve the accuracy of the data.

The Foundation staff work toward this goal by limiting the number of special competitions requiring individual program announcements and solicitations, planning for such competitions as far in advance as possible, and initiating clearance processes at least six months prior to the anticipated proposal deadline. NSF expects increased use of the new systems in FY 2001, and expects to see additional progress toward meeting this goal next year.

PERFORMANCE AREA: CUSTOMER SERVICE - TIME TO DECISION

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 highly valued. 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 goal will be maintained in FY 2001.

Customer Service Standard: NSF's long-term goal continues to be processing 95% of proposals within six months of receipt. In other words, NSF should be able to tell applicants whether their proposals have been declined or recommended for funding within six months of receiving them.

INVESTMENT PROCESS GOAL 7

Maintain the FY 1999 goal to process 70% of proposals within six months of receipt, improving upon the FY 1998 baseline of 59%.

PERFORMANCE INDICATOR

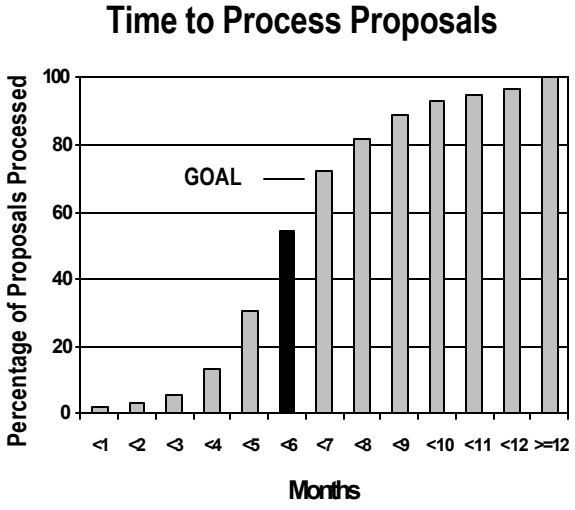
Percent of proposals processed within six months of receipt.

	FY 1998	FY 1999	FY 2000	FY 2001
Baseline	59%			
Goal		70%	70%	70%
Actual		58%	54%	

RESULT:

THIS GOAL WAS NOT ACHIEVED.

In FY 2000 more than half (54%) of all proposals were processed within six months of receipt, while an additional 35% of proposals were processed between six and nine months of receipt. 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. Data show that about 71% of proposals were fully processed in less than seven months, and about 82% of proposals were processed in less than 8 months, as shown.



One of the most significant issues raised by applicants (see results of the ACSI customer survey, described under Investment Process Goal 3) is the amount of time it takes for NSF to process proposals. NSF is reviewing the steps needed to decrease the processing time of proposals to find ways to process them more quickly.

One factor leading to delay in processing is that some programs at NSF prefer to conduct merit review by mail rather than by panel. Mail reviews often take longer to complete. Another factor is that some programs tend to hold a few highly rated proposals until the end of the fiscal year, or even into the next fiscal year, in anticipation that more funds might become available. In FY 2000 a few programs reported temporary staffing shortages. This slowed down their review process. This situation has been corrected.

In addition, the processing of international awards often takes more time than standard awards. This is because the process of making international awards necessarily involves additional major steps with more program units involved, increasing the amount of time required for processing. For example, in many cases, foreign country approval of a matching proposal must be obtained, which often results in unpredictable delays.

In FY 2001 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 reduce overloads and bottlenecks, and by carefully tracking the stage of processing and received date of all proposals. In addition, some internal organizations are reconsidering the practice of holding over proposals for potential funding until the next fiscal year. Some have added "performance on prompt handling of proposals" to the performance evaluation criteria of their staff.

PERFORMANCE AREA: MAINTAINING OPENNESS IN THE SYSTEM

NSF believes it is important that the proposal and award process be open to new people and new ideas in order to help ensure that NSF is supporting research at the frontier of science, engineering, and education. 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 2001.

INVESTMENT PROCESS GOAL 8

The percentage of competitive research grants going to new investigators will be at least 30%, 3% over the FY 1998 baseline of 27%.

PERFORMANCE INDICATOR

Percent of competitive research grants going to new investigators.

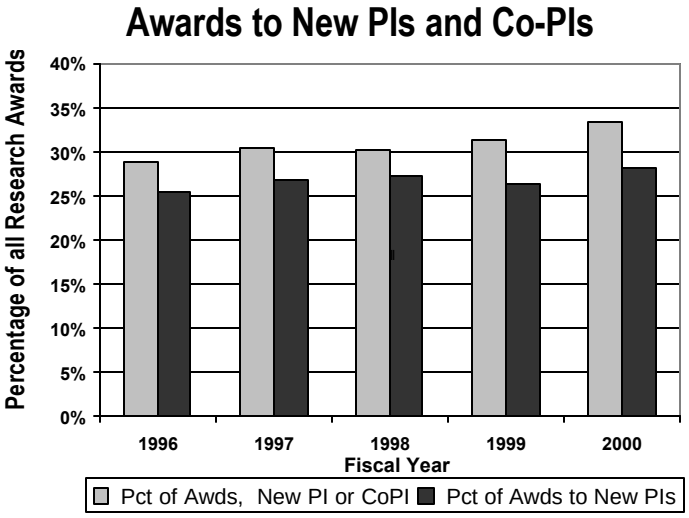
	FY 1998	FY 1999	FY 2000	FY 2001
Baseline	27%			
Goal		30%	30%	30%
Actual		27%	28%	

RESULT:

THIS GOAL WAS NOT ACHIEVED.

The percentage of competitive research grants issued to new investigators was 28% in FY 2000, one percent higher than in FY 1999. This is a challenging goal for NSF. There continues to be a wide disparity in the funding rates of "new" Principal Investigators (PIs) and "prior" PIs – 24 percent and 40 percent, respectively in FY 2000.

It is important to note that this goal counts "grants" to new investigators. It does not count *all* new investigators who may be collaborating on a project – it counts only new *PIs* - not new *co-PIs* – which would be the case if two or more new applicants collaborating together received an award. Also, the goal does not count new co-PIs on awards where the PI has had prior NSF support, as is often the case. If we count both PIs and co-PIs who are new, we find that more than 32% received support in FY 1999 and more than 33% received support in FY 2000. The following bar-chart compares the percentage of all research awards where both new PI and co-PI's are counted (first column) to the percentage of all research awards where only new PI's are counted (second column), for fiscal years 1996, 1997, 1999, and 2000. This result indicates that many new investigators are receiving their first support as co-PIs on NSF awards.



NSF will continue to seek creative and innovative proposals from new investigators. Program staff will attend scientific meetings, conferences, and conventions and will conduct site visits to promote awareness of the research and education opportunities at NSF and to encourage new investigators to submit proposals. NSF will examine trends, such as whether the pool of new investigators is smaller than in previous years or whether they are submitting fewer proposals, and if needed, use this information to modify targets in the future.

PERFORMANCE AREA: ATTENTION TO INTEGRATION OF RESEARCH AND EDUCATION – IN PROPOSALS

Integrating research and education appears as part of the investment strategies supporting all of NSF's Outcome Goals for education and research as described in the NSF 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. NSF wants all awardees to give deliberate attention to their effectiveness as both researchers and educators. This goal will also help to achieve full use of both merit review criteria, Investment Process Goal 2. This goal was introduced in FY 2000 and will not be continued in FY 2001.

INVESTMENT PROCESS GOAL 9

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.

PERFORMANCE INDICATOR

Outreach to community; implementation of system to verify that PIs address the integration of research and education in proposals.

RESULT:

THIS GOAL WAS ACHIEVED.

In FY 2000 NSF implemented an electronic Program Announcement Template (PAT) clearance process that is used by NSF staff to generate announcements and solicitations. Use of the PAT ensures that PIs are asked to address the integration of research and education in all announcements and solicitations. In addition, the Foundation has included language in the Proposal and Award Manual, the Grant Proposal Guide, and the FY 2000 Guide to Programs regarding the importance of the integration of research and education.

In order to verify that PIs are addressing the integration of research and education, NSF asks Committees of Visitors (COVs) to assess whether the broader impacts of the proposed activity are being addressed in proposals and by reviewers and NSF staff as part of the merit review process. The COV reporting template has been modified in FY 2001 to explicitly address the use of both merit review criteria by reviewers and program staff.

PERFORMANCE AREA: ATTENTION TO INTEGRATION OF RESEARCH AND EDUCATION – IN REVIEWS

This goal will help to achieve full use of both merit review criteria, as stated in Investment Process Goal 2, which requires attention being given to *both* merit review criteria by reviewers. To achieve full use of both merit review criteria requires that attention be given to them both in proposals and by reviewers and staff. Once proposals include information on plans for integrating research and education (Investment goal 9), then reviewers will be able to address those plans in their reviews. This will also aid NSF staff in using the information in making funding decisions. This goal was introduced in FY 2000 and will not be continued in FY 2001.

INVESTMENT PROCESS GOAL 10

NSF will develop and implement a system/mechanism to request and track reviewer comments tied to the merit review criterion "What are the broader impacts of the proposed activity?"

PERFORMANCE INDICATOR

Outreach to community; implementation of system to track reviewer comments.

RESULT:

THIS GOAL WAS ACHIEVED.

During FY 2000 screens were redesigned in FastLane (NSF's electronic proposal and review system) so reviewers will be able to address each merit-review criterion separately in FY 2001. This information is used to aid in the determination of whether NSF has achieved this goal.

NSF modified program announcements to encourage applicants and reviewers to address these criteria in proposals and reviews. NSF has recently re-issued guidance to the proposing institutions and reviewers that stresses the importance of addressing both merit review criteria in the preparation and evaluation of proposals submitted to NSF. NSF staff continue to stress the importance of reviewers addressing the "*broader impacts*" criterion whenever they attend NSF-sponsored seminars, science meetings, site visits, conferences, and conventions.

PERFORMANCE AREA: DIVERSITY - NSF APPLICANTS

In 1980 legislation gave NSF explicit responsibility for addressing issues of equal opportunity in science and engineering. This reflected the serious under-representation of women, minorities, and persons with disabilities in the science and engineering workforce. Recognizing that progress toward all Outcome Goals for research and education requires diversity of intellectual thought, NSF is emphasizing attention in all its programs to enhancing the participation of groups currently under-represented in science and engineering, including women, under-represented minorities, and persons with disabilities. The long-term objective is to have a science and engineering workforce that mirrors the U.S. population. This was a new goal in FY 2000, based on a revised FY 1999 goal. It will be revised as a new goal in FY 2001 to broaden the participation of under-represented groups in the reviewer pool.

INVESTMENT PROCESS GOAL 11

NSF will identify mechanisms to increase the number of women and under-represented minorities in the proposal applicant pool, and will identify mechanisms to retain that pool.

PERFORMANCE INDICATOR

Mechanisms to attract proposals from members of under-represented groups in order to increase the total applicant pool; mechanisms to retain the applicant pool.

RESULT:

THIS GOAL WAS ACHIEVED.

NSF is strongly committed to increasing the participation in all NSF activities of science and engineering researchers, educators, and students from groups currently under-represented in the science and engineering enterprise. Congress enacted legislation giving 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.

NSF is committed to the principle of diversity and deems it central to the programs, projects, and activities it considers and supports. NSF continues to work toward increasing diversity in its proposal applicant pool through the following means:

- To place the issue on equal footing with the quality of research being supported, NSF issued Important Notice No. 125 to presidents of universities and colleges encouraging PIs to address the merit review criterion – what are the broader impacts of the proposed activity - which embraces integrating diversity into all NSF supported activities;

- Developing and increasing funding for specialized programs designed to promote diversity;

- Recruiting members of under-represented groups for merit review panels, COVs, and NSF workshops and conferences; and

- Strongly encouraging women, minorities, and persons with disabilities to compete fully in NSF programs.

NSF is revising this long-term goal to extend its efforts as it continues to pursue diversity in the applicant pool. A new goal designed to broaden participation of under-represented groups in FY 2001 will build on the results of this goal by targeting the reviewer pool.

PERFORMANCE AREA: FACILITIES OVERSIGHT

The goals which follow are for federal science, space and technology agencies which support construction projects and have responsibility for managing facilities (NSF, NASA, DOE). NSF reports in two categories for this performance area: *Construction and Upgrade of Facilities, and Operations and Management of Facilities*.

NSF provides support for large multi-user facilities. These facilities meet the needs of the academic community for access to state-of-the-art research platforms 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. This support provides 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 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 to Congress, 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 educators, and cooperates with other agencies in construction of facilities for use across broad communities of researchers and educators. 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 facility directors to ensure that the 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 in FY 1999 a new Performance Reporting System (as a module of the existing FastLane system), to collect information on 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. In FY 1999 NSF developed a general facilities reporting template for use in collecting information on the construction, upgrade, and operations goals. This reporting system was linked to the new Project Reporting System (as a module of the existing FastLane system). The manager of each facility reports the data to NSF. FY 1999 was the first year that NSF collected data on these goals.

FACILITIES OVERSIGHT - CONSTRUCTION AND UPGRADE OF FACILITIES

INVESTMENT PROCESS GOAL 12

Maintain the FY 1999 goal to keep construction and upgrades within annual expenditure plan, not to exceed 110 percent of estimates.

PERFORMANCE INDICATOR

Comparison with planned annual cost.

Of the eleven construction and upgrade projects supported by NSF, all were within annual expenditure plans; six met the planned annual cost and five were less than the estimated cost. This goal was achieved in FY 1999. The majority of facilities were within annual spending estimates of 110%. This goal will be revised in FY 2001 to require that 90% of NSF-supported facilities keep construction and upgrades within their annual expenditure plan.

RESULT:

THIS GOAL WAS ACHIEVED.

INVESTMENT PROCESS GOAL 13

Maintain the FY 1999 goal to keep construction and upgrades within annual schedule, total time required for major components of the project not to exceed 110 percent of estimates.

PERFORMANCE INDICATOR

Comparison with planned annual schedule.

Of the eleven construction and upgrade projects supported by NSF, seven reported that all of their scheduled milestones were completed within 110 percent of the estimated time for completion. For four projects, missed milestones were due to circumstances beyond the project manager's control. For example, one construction project was dependent upon the research and development of new instrumentation, the results of which were delayed. In other projects, the missed milestone was due to difficulty acquiring necessary parts; non-performance of a sub-contractor; and underestimation of the complexity of the work. One project did not report. In FY 2001 NSF program managers are working more closely with project managers to ensure all NSF-supported construction/upgrade projects achieve this goal. This goal will be revised in FY 2001 to require that 90% of NSF-supported facilities keep their planned construction and upgrades within annual schedule.

RESULT:

THIS GOAL WAS NOT ACHIEVED.

INVESTMENT PROCESS GOAL 14

For all construction and upgrade projects initiated after 1996, when current planning processes were put in place, keep total cost within 110 percent of estimates made at the initiation of construction.

PERFORMANCE INDICATOR
Comparison with planned total cost.

This goal will be maintained in FY 2001.

RESULT:

THIS GOAL DID NOT APPLY IN FY 2000 OR FY 1999; THERE WERE NO CONSTRUCTION PROJECTS COMPLETED IN FY 2000 OR FY 1999.

FACILITIES OVERSIGHT - OPERATIONS AND FACILITIES

Facilities must operate efficiently and reliably and must be available on schedule if they are to be useful to those they serve. NSF program officers work closely with facility directors to ensure that facilities have appropriate resources to operate reliably and schedule necessary maintenance.

INVESTMENT PROCESS GOAL 15

Maintain the FY 1999 goal to keep operating time lost due to unscheduled downtime to less than 10 percent of the total scheduled possible operating time.

PERFORMANCE INDICATOR
Comparison to scheduled operating time.

Of the 26 reporting facilities, 22 met the goal of keeping unscheduled downtime to below 10% of the total scheduled operating time. Four reported unscheduled downtime greater than 10%.

RESULT:

THIS GOAL WAS NOT ACHIEVED.

In FY 2000 NSF reviewed the FY 1999 data collection and reporting effort and made modifications to the FY 2000 and FY 2001 systems in order to improve the efficiency, clarity and accuracy of the process. This included allowing for reporting on construction/upgrade activities at facilities funded through the Research and Related Activities Account, refining the clarity of the on-screen language, addressing the facilities goals more accurately, automating most of the output, and instituting a stage for collecting estimates. NSF program staff will work more closely with project managers to ensure that all achieve this goal in FY 2001.

The *on time* and *on schedule* goals for FY 2001 will be revised slightly so that when at least 90 percent of facilities meet the federal standard, the goal is considered achieved. These changes are being made because NSF places great importance on accurate planning for construction and upgrade of facilities, but we recognize that the unique, state-of-art projects being supported stretch the limits of technological capability. As a result there may be unexpected construction delays and/or unforeseen expenditures. NSF expects that the vast majority of its projects will be within budget and on schedule. However, we do not believe the agency should be considered unsuccessful overall in these areas if a small percentage of facilities are unable to meet the goals. Therefore, to provide the flexibility necessary for NSF to report realistic and achievable goals, we are reestablishing the target level of success at 90% of the facilities for FY 2001. This change will be evaluated over time to determine if 90% is the appropriate level for this goal.

The *operating time* goal will also be revised from 100% to 90% for FY 2001. NSF recognizes that some facilities may have a failure rates greater than 10%, but that this is balanced overall by facilities that operate more reliably. NSF expects that the vast majority of facilities will keep operating time lost due to unscheduled downtime to less than 10% of the operating time. We do not believe the agency should be considered unsuccessful if a small percentage of the facilities are unable to meet this goal. Therefore, to provide the flexibility necessary for NSF to report realistic and achievable goals, we are reestablishing the target level of achievement at 90% of the facilities for FY 2001. This change will be evaluated over time to determine if 90% is the appropriate level for these goals

D. TABLE OF EVALUATIONS

Table 2 below provides information on the program assessments and evaluations other than Committee of Visitor and Advisory Committee assessments - with one exception – the Major Research Instrumentation (MRI) program. The MRI program is an agency-wide activity, and is the first Committee of Visitor (COV) review NSF has contracted to an external private vendor.

The table lists other types of evaluations, not used in GPRA performance assessment, that were completed in FY 2000 and for which information was available at the time this report was prepared. These reports, studies, and evaluations are frequently used in setting new priorities in a field or in documenting progress in a particular area. The reader is encouraged to review the reports for additional information on findings and recommendations which are beyond the scope of this report. A table showing the schedule for COV assessments appears in Section XV. A discussion of results obtained for Outcome Goals based on the COV and advisory committee assessments is presented in Section V. A.

Reports (other than COV reports) produced by NSF are available online at http://www.nsf.gov/pubs/start.htm using the NSF's online document system and the publication number indicated. COV reports will become electronically available in December, 2001.

Information on obtaining reports produced by the National Research Council or National Academy of Sciences can be found online by searching www.nap.edu or from the National Academy Press, 2101 Constitution Avenue, N.W., Lockbox 285, Washington, D.C. 20055 (1.800.642.6242).

TABLE 2

EVALUATIONS COMPLETED IN FY 2000	SCOPE	FINDINGS	AVAILABILITY
Report of the Committee of Visitors: Major Research Instrumentation Program	Initial review of MRI program for period FY 1995-FY 1999; program processes and management; program results and goals specific to MRI program.	Program effectively uses merit review process to generate appropriate portfolio of awards based on quality of proposed instrument; not as effective in use of "broader impact" criterion; evaluation of progress in meeting most outcome goals difficult because few results have yet been achieved and some are beyond the scope of the program.	Will be electronically available through NSF web site December 2001

EVALUATIONS COMPLETED IN FY 2000	SCOPE	FINDINGS	AVAILABILITY
Progress of the Engineering Education Coalitions	Review of effectiveness and progress in educational reform through engineering coalitions program.	Coalitions made important contributions and facilitated the implementation of performance-based accreditation standards (ABET 2000).	NSF 00-116 May 2000
Measuring the Science and Engineering Enterprise: Priorities for the Division of Science Resource Studies in 2000	Review of the SRS portfolio of data collection, acquisition, and analysis activities.	Recommends expansion and modification of SRS data activities such as: increased interaction with users and customers; increase timeliness of release data; expand data collections for some areas; revise collection surveys.	National Research Council
Challenges in Collecting and Reporting Federal Research and Development Data	Comparison of numbers reported by the federal agencies as outlays for federal R&D on National Science Foundation surveys with those reported by federal R&D performers as expenditures or reimbursements from federal agencies.	Source of discrepancy is almost exclusively with reporting by performers; CRS suggests further study and increased support to improve R&D data collection and reporting.	Congressional Research Service, Library of Congress Order Code RL30413
Nanotechnology Research Directions: IWGN Workshop Report	Identifies challenges and opportunities in nanotechnology field; outlines how advances in field can impact national economy, health care and national security.	Recommends long term fundamental nanoscience and engineering research, synthesis and processing 'by design' of material building blocks, and education and training of future workforce.	See reference 1
Condensed-Matter and Materials Physics – Basic Research for Tomorrow's Technology	Scholarly assessment of field as part of a new survey of physics, *Physics in a New Era*, that is in progress.	Provides advice for support of the field and what areas should receive increased investment.	National Academy Press

Reference 1: http://www.nsf.gov/home/crssprgm/nano/start.htm.

EVALUATIONS COMPLETED IN FY 2000	SCOPE	FINDINGS	AVAILABILITY
Astronomy and Astrophysics in the New Millennium	Assessment of field, identifies fundamental scientific challenges, assesses infrastructure and impact on society, international activity, and balance of national objectives, coordination of federal agencies.	Report identifies key areas of astronomy and astrophysics for advances to increase understanding of the universe.	National Research Council
Materials Science and Engineering – Forging Stronger Links to Users	Addresses the relationships among academia, government, government laboratories and industry in the materials science and engineering field, including the relationships among the producers and users of materials and the processes of innovation.	In depth study covers three sectors: automotive industry, jet-engine industry, and computer-chip and information-storage industries. Provides advice for mechanisms to support pre-competitive research, multidisciplinary research, and the facilitation of university-industry interactions.	National Academy Press
Cooperative Stewardship – Managing the Nation's Multidisciplinary User Facilities for Research with Synchrotron Radiation, Neutrons, and High Magnetic Fields	To explore possible strategies to address changing usage of research facilities (synchrotron radiation, neutron beam, and high-magnetic field facilities) and changing roles of the supporting agencies.	U.S. funding agencies should adopt a cooperative stewardship model for managing facilities.	National Academy Press
NSF Geosciences Beyond 2000, Understanding and Predicting Earth's Environment and Habitability	A decadal outlook for the geosciences evaluating opportunities and requirements for research, education and infrastructure.	The report outlines the scientific programs needed to continue the expansion of the basic knowledge of Earth systems.	NSF 00-27

EVALUATIONS COMPLETED IN FY 2000	SCOPE	FINDINGS	AVAILABILITY
National Research Council/National Academy of Sciences: Illuminating the Hidden Planet: The Future of Seafloor Observatory Science	Review of merit of seafloor observatories.	Planning and implementation of a seafloor observatory program should move forward.	National Research Council/ National Academy of Sciences July 2000
National Research Council/National Academy of Sciences: Basic Research Opportunities in Earth Science	Review of program balance and research opportunities.	Recommendations address new mechanisms to exploit research opportunities.	National Research Council/ National Academy Press 2000
The Graduate Research Traineeships (GRT) Program	GRT projects evaluated on the number of students reached and on processes carried out to meet goals.	As of 1998, almost half of the nearly 200 students receiving a Ph.D. with partial support through the GRT program had obtained postdoctoral positions and half were working in education, government, or private employment.	Available from NSF in FY 2001
Collaboratives for Excellence in Teacher Preparation Program (CETP)	Review of changes in learning infrastructure, faculty involvement, and student outcomes.	Too early for information on students; program is meeting objectives in areas of learning infrastructure and faculty involvement.	Available from NSF in FY 2001
Mathematical Sciences and Their Applications Throughout the Curriculum: Final Report	To determine whether curricula for undergraduates was developed and new partnerships among higher education institutions were created by initiatives.	Most initiatives successful in developing and disseminating materials; less success in developing and maintaining institutional partnerships.	NSF 00-73
Best Practices Study of Federal Minority Undergraduate SMET Programs	To determine best practices in programs for undergraduate minority programs across NSF, NASA, and HHS.	All programs had recognized strengths; NSF program focused on less well-prepared students.	Available from NSF in FY 2001

EVALUATIONS COMPLETED IN FY 2000	SCOPE	FINDINGS	AVAILABILITY
Program for Gender Equity (PGE)	Review of collaborations developed among educational organizations, number of individuals impacted by projects, findings on gender equity.	Program successful in all areas: most projects replicated or institutionalized; nearly 85,000 participants served.	Available from NSF in FY 2001
Faculty Early Career Development (CAREER) Program	Study of first three years of award impact and value to awardees, to determine if CAREER awardees demonstrated greater career advancement than non-CAREER awardees.	CAREER awardees reported more rapid advancement in professional careers than non-CAREER awardees.	Available from NSF in FY 2001

VI. VERIFICATION AND VALIDATION

A. QUALITY OF THE REPORTED PERFORMANCE INFORMATION

In FY 1999 concerns were expressed by the General Accounting Office (GAO) with regard to the quality of reported performance information used by NSF. To address these concerns in FY 2000, NSF engaged an external third party, Price-waterhouseCoopers LLP (PwC), to verify and validate selected FY 2000 GPRA performance data as well as the process used in collecting and compiling data and information. In their final reports, PwC concluded that NSF was reporting its GPRA measures with "sufficient accuracy such that any errors, should they exist, would not be significant enough to change the reader's interpretation as to the Foundation's success in meeting the supporting performance goal . . . ." Furthermore, PwC concluded that NSF "relies on sound business processes, system and application controls, and manual checks of system queries to confirm the accuracy of reported data. We believe that these processes are valid and verifiable."

KPMG LLP, an independent certified public accounting firm, was selected by the NSF Inspector General to perform an audit of NSF's FY 2000 financial statements. Their review included a review of the collection process and maintenance of data and information for NSF's GPRA goals. NSF received an unqualified opinion stating that the principal financial statements were fairly stated in all material respects. The independent auditors did not report any material weaknesses in internal control or material noncompliance with laws or regulations.

All data are imperfect in some way. Establishing responsible and reasonable verification and validation procedures and understanding data limitations requires a balanced approach. NSF acknowledges the need to improve data systems for collecting and maintaining performance information and data as budget and time allow, and regards this as an evolutionary process which will continue to improve with time. NSF is comfortable with the quality of the data it uses in assessing the overall progress of the agency in meeting performance goals and makes use of the information it gains through performance reporting to improve policies, practices and management of the agency. Implementing GPRA has enabled NSF to gather information in a structured way, and to address issues in a more formal, focused way than in the past.

Because basic research and education projects rarely produce results in less than three to five years, it is difficult to compare the outcomes reported in the fiscal year with the funds that were obligated in that year. In some cases, the results of NSF support may not be recognized and reported for twenty years or more. Because the GPRA reporting schedule is annual, NSF conducts an annual assessment or evaluation of results submitted to the agency in the fiscal year, which is a retrospective evaluation, carried out by external experts. This retrospective evaluation makes use of the alternative form for reporting, to cover about thirty percent of NSF's total portfolio in one year. This makes sense for NSF's Outcome Goals, which are long-term goals, and are not expected to be achieved in a short time period. Nonetheless, we are

concerned that the current form of reporting goal achievement under GPRA does not convey the accomplishments of NSF or the full value of the NSF investment. To help the reader understand the level and accomplishment of performance for the Outcome Goals, examples are included to illustrate achievements reported during the fiscal year. While they may appear to be anecdotal, they can be traced to NSF-supported awards.

B. DATA VERIFICATION AND VALIDATION ACTIVITIES

For reporting goal achievment, all of NSF's goals are aggregated across the agency. To enable aggregation, NSF developed reporting templates in FY 1998, and data modules to collect data uniformly across the agency. These modules and templates were revised and refined in FY 2000 and were based on information gained in using the templates and systems in FY 1999. In FY 1999 NSF established a Data Quality Program to assess and improve the quality of data within the Foundation. NSF will continue to further refine data collection methods and systems to address areas in need of improvement as time and funds allow.

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

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.

In FY 2000, NSF increased the expected quality of information for the Outcome Goals in two ways:

1. NSF changed the two-level standard from *successful/minimally effective* to *successful*.
2. NSF required thorough justification for "grades."

NSF staff update and revise guidelines and reporting procedures for collecting data for the Outcome Goals annually. The Committee of Visitor (COV) guidelines were revised in FY 1999 and 2000 to incorporate the GPRA-related reporting requirements. COVs address a common set of questions for all programs reviewed in a fiscal year. Reporting guidelines were also developed for Advisory Committees to enable uniform, systematic aggregation of information. The results of using the new procedures helped to identify areas for improvement to the guidelines. These were incorporated for FY 2000 reporting and guidelines will be revised in FY

2001 based on experiences in FY 2000. The experience gained while conducting these assessments has also been used in revising the FY 2001 and FY 2002 Performance Plans and goals, and the updated Strategic Plan.

In addition, for FY 2000 NSF established parameters to define the acceptability and reliability of the qualitative information it uses. NSF defined the quality of the information it uses to insure uniform quality of results and applied stricter definitions of success in determining whether Outcome Goals had been met. NSF used a confidence limit to identify non-substantive information. Information falling outside the confidence limit was excluded from use.

The overall effect of applying these stricter definitions was to raise the expected performance level and reduce the aggregated success rate for NSF in FY 2000. However, the performance of the agency as a whole in FY 2000 was very much the same as in FY 1999 and positive trends are beginning to emerge. Many of the same issues identified by external groups in FY 1999 were identified in FY 2000. This is an interesting result in itself, since the Outcome Goals make use of judgement by different groups of external experts each year, and one might expect the result to be different if done by different groups, but this was not the case. Thus, this second year of reporting validated results obtained in the first year. A more complete picture will be obtained when results for the third year of reporting are known.

Information gathered from external sources for use in measuring performance related to the Outcome Goals is checked by NSF staff, reviewed by groups of external evaluators, and is subject to audit and tracking by association with grant numbers. In assessing its performance NSF makes use of reports generated by COVs who provide judgements. The scores and comments are compiled and aggregated to determine the success of the agency in meeting the Outcome Goals. This process was reviewed by PwC, who noted that the "approach NSF uses to assess its performance under these specific qualitative measures is reasonable"... and that in comparing NSF's results with PwC's results using the process established by NSF, "overall conclusions regarding program success or lack thereof in respect to individual goals remained largely unchanged."

It is likely that NSF will continue to make use of external third parties on an appropriate schedule, to verify and validate data used in reporting performance goals as funds are available for this purpose.

C. TYPES AND SOURCES OF PERFORMANCE DATA AND INFORMATION

The data used in measuring performance are developed by and come from a variety of sources. Much of the data originate outside the agency, and quality is beyond the control of the NSF. Data come from administrative records, awardee reports, external committee reports, and internal data systems. Additional information can be found in the FY 2001 Performance Plan.

Quantitative data is used primarily in assessing the Investment Process and Management Goals. Most quantitative data used in assessing performance is collected using internal data systems and is reviewed by staff on a quarterly schedule.

Most of the qualitative information used in assessing Outcome Goal performance is provided to NSF by external evaluators (COVs) near the end of the fiscal year, and is reviewed by NSF senior management as it becomes available.

Collection of data is dependent on the type of data/information. Collection of data for all goals takes place throughout the year and is completed near the end of the fiscal year. Data are collected into reports for each goal by a group staff having reporting responsibility for the particular goal. The data obtained are reviewed on a continuing basis by senior management throughout the year, in order to observe whether the results are as expected, whether performance needs to be improved, whether targets need adjustment, or whether the information being obtained is useful to the agency. Data collection systems are also under constant observance and refinement.

D. DATA LIMITATIONS

Specific data limitation issues are discussed below. The NSF FY 2001 Performance Plan contains additional information on data sources and limitations.

This is the second year in which reports were collected, tabulated, and an assessment of NSF's performance was completed. Several data quality/limitation issues were identified in the first year of reporting. The agency worked to address these issues during FY 2000. The issues included: incomplete data collection systems related to some of the quantitative goals (such as the goals related to Facility Operations – Investment Goals 12-15); the need to improve report templates to ensure that the performance information provided by external groups is more complete and consistent for the qualitative Outcome Goals; and explanations for goals that were missed.

Steps were taken to improve the quality and value of performance data for the Outcome Goals. They included improved reporting templates for collecting program performance information from external committees by asking for more complete justifications for ratings. We note an improved quality and consistency of COV reports for FY 2000, but note they are still not optimal. NSF has modified the COV reporting template guidelines for FY 2001 to further improve consistency and completeness. NSF staff will work more closely with COV members to ensure improved reporting. This will aid NSF in aggregating qualitative information for measuring progress in achieving the Outcome Goals.

NSF employs an alternative form for determining progress made in achieving its Outcome Goals for research and education. In FY 1999 NSF made use of the alternative form using the two-standard approach required by the Act (*successful* or *minimally effective*). In doing so, NSF learned that there was little to be gained in using *minimally effective* standard, and that in many

instances it was confusing to the evaluators. Therefore, for FY 2000, NSF defined one standard only: the *successful* standard. The effect of this change was to increase the level of expected performance for the Outcome Goals.

When NSF collects performance information it asks COVs to indicate when data is not adequate or available to evaluate progress toward meeting an Outcome Goal. NSF found in FY 1999 and FY 2000 that external evaluators did not always have adequate information available to judge each program in use of the merit review criteria; in achieving increased participation from under-represented groups; and, in achieving science and math skills for ***all*** Americans. NSF management is reviewing means that will help NSF staff to provide this information for FY 2001 assessments. In some instances, data is difficult to obtain. An examples is complete data describing the participation of under-represented groups, which is voluntary.

NSF is also reviewing the wording of goals to correct issues which created difficulty when aggregating results in FY 1999 and FY 2000. For example, Outcome Goal 3 combines achieving increased diversity with achieving a globally-oriented workforce. While NSF was judged successful in achieving a globally-oriented workforce in most programs, it was judged less successful in achieving increased diversity. Consequently, NSF is not able to indicate success across the entire agency in FY 2000 for this goal, although some aspects of the goal were realized by programs, in particular those programs with funds targeted directly to meet these goals.

A similar situation arose in evaluating Outcome Goal 4, which targets improved math and science skills for ***all*** Americans. NSF programs were successful when they had clearly invested funds to support activities relevant to achieving this goal. It was less apparent to external groups whether success had been achieved for programs not designed to specifically address this goal, and the resulting COV reports did not provide clear evidence of success at the aggregate level. Therefore, for this goal, we are unable to indicate successful performance for the agency.

A new format has been adopted for NSF's goals in FY 2001 which we hope will help to alleviate some of these issues: the five Outcomes Goals have been organized under three headings, each with independent indicators. This will aid assessment by COVs to address the indicators separately when they are relevant to the program being evaluated.

Another limitation noted was for Investment Process Goal 8, Maintaining Openness in the System. It was found that the identification of new PIs was inaccurate on occasion, and steps were taken to identify such individuals in the NSF PI system more carefully. For Investment Process Goals 12-15 on Facility Oversight, the reporting system was revised and implemented in FY 2000. This system was provided to facility managers located at universities who must use the NSF developed system to report data that support this goal. There was lack of agreement in FY 1999 on how the required data were defined, which led to different interpretations. This deficiency was addressed in FY 2000. However, facility managers are still gaining experience in collecting and providing information needed for reporting these goals.

For the quantitative Management Goal 3 - Staff Diversity - a reported data limitation for this goal is that an applicant by law cannot be required to provide gender and ethnicity information.

Thus, it is certain that the results for this measure are not accurate. Goals which require voluntary self-reporting are also subject to being incomplete or inaccurate.

Finally, in reporting results for all goals in FY 1999, NSF did not always have a complete understanding of why some goals were not met. For FY 2000 NSF revised report templates for collecting information across directorates and offices within NSF. Each reporting organization within NSF was asked to provide a summary of performance at a lower organizational level, and to provide explanations when agency goals were not met along with plans to meet those goals. This provided the agency with more complete information on goal performance in FY 2000 and has helped to identify several important obstacles critical to achieving some goals. This information is being used to develop implementation strategies for meeting targets in future fiscal years.

E. OTHER ISSUES - TIMING

One of the most significant challenges for NSF is that results of research and education investments do not appear annually or on schedule. NSF faces other timing issues in preparing this report. Such timing issues may be shared by other agencies. One timing issue is related to NSF's reliance on external committees to conduct assessments after the close of the fiscal year. Materials are prepared in advance, but there is a narrow window of time between the end of the fiscal year and the start of the calendar year for the assessment to be conducted by external groups and the results to be finalized and written by the external committees. The committee reports must be submitted to the agency, and reviewed by the agency. NSF relies on the availability and cooperation of the external community and their ability to deliver their assessments on a tight schedule.

In addition, the timing and phasing of the annual plan, collection of information, and data for reporting have been difficult to coordinate with the budget process. To optimize goals and plans for the new fiscal year, NSF must review progress from the prior fiscal year, and make revisions to the annual plan for the upcoming year. However, the Performance Plan is typically due well before the results of the prior fiscal year are known. This creates an awkward situation, in that an early Performance Plan may need significant revisions to best serve the agency.

In FY 1999 and FY 2000 NSF found that the time needed to collect and review the annual performance data, and incorporate changes into the FY 2001 and FY 2002 annual performance plans in a way which we believe benefits the process and lead to desired results, was insufficient to meet the current schedule set by law. We are reviewing staffing and procedural mechanisms to accelerate the process for aggregating performance results. However, this is unlikely to yield an agency result at the right time to develop a plan appropriate for the upcoming year.

VII. MAJOR MANAGEMENT CHALLENGES

The United States Senate Committee on Governmental Affairs annually conducts oversight of each agency to ensure that the federal government delivers better results to its citizens and taxpayers. The Senate Committee works through the Office of the Inspector General (OIG), annually requesting that each agency's OIG identify the ten most serious long-term management challenges facing their respective agency.

In an FY 1999 report to the Senate Committee (letter dated 1 December 1998), the NSF OIG identified ten significant NSF management challenges:

MAJOR MANAGEMENT CHALLENGES FOR FY 1999 AND FY 2000

1. *Managing an effective merit review system
2. Capitalizing on NSF strengths when responding to increased expectations
3. Using the Government Performance and Results Act
4. Responding to the Chief Financial Officers Act
5. *Implementing FastLane
6. Managing the Antarctic Program
7. Sustaining high scholarship and integrity
8. Spending funds effectively and efficiently
9. Managing an effective system for cost sharing
10. Managing salaries and administrative resources

*An * denotes areas included under goals in the FY 1999 and FY 2000 Performance Plans*

NSF responded to the Senate Committee in a letter dated September 28, 1999, noting that the NSF IG had stated overall that the Foundation is well managed, and accordingly found these issues to be challenges, rather than managerial "deficiencies".

In FY 2000 the NSF OIG report to the Senate Committee identified 10 management challenges which it considered to be the most important for NSF. The NSF OIG found that the overall NSF investment portfolio was healthy and the Foundation did not have significant management deficiencies. The OIG identified the same list of challenges for NSF in FY 2000 as it did in FY

1999. The OIG also stated that the Foundation management had made continuous progress on each of these items in FY 2000.

In its FY 1999 Performance Report to Congress NSF did not discuss each of the major management challenges identified by the NSF OIG. In discussions with GAO the OIG indicated that NSF is taking effective steps to respond to these challenges, and did not need to include each of them in performance reports or future performance plans. However, the OIG did express concerns about areas related to effective oversight and the need for NSF to be alert to emerging situations that could result in problems. NSF senior management, responding to the concerns of the NSF OIG, continually review and monitor each of these areas and continue to include select areas for assessment in annual performance plans.

For FY 2001, the NSF OIG has identified 10 areas (see below) including some areas identified in previous years, and several new areas for NSF to monitor:

FY 2001 MAJOR MANAGEMENT CHALLENGES

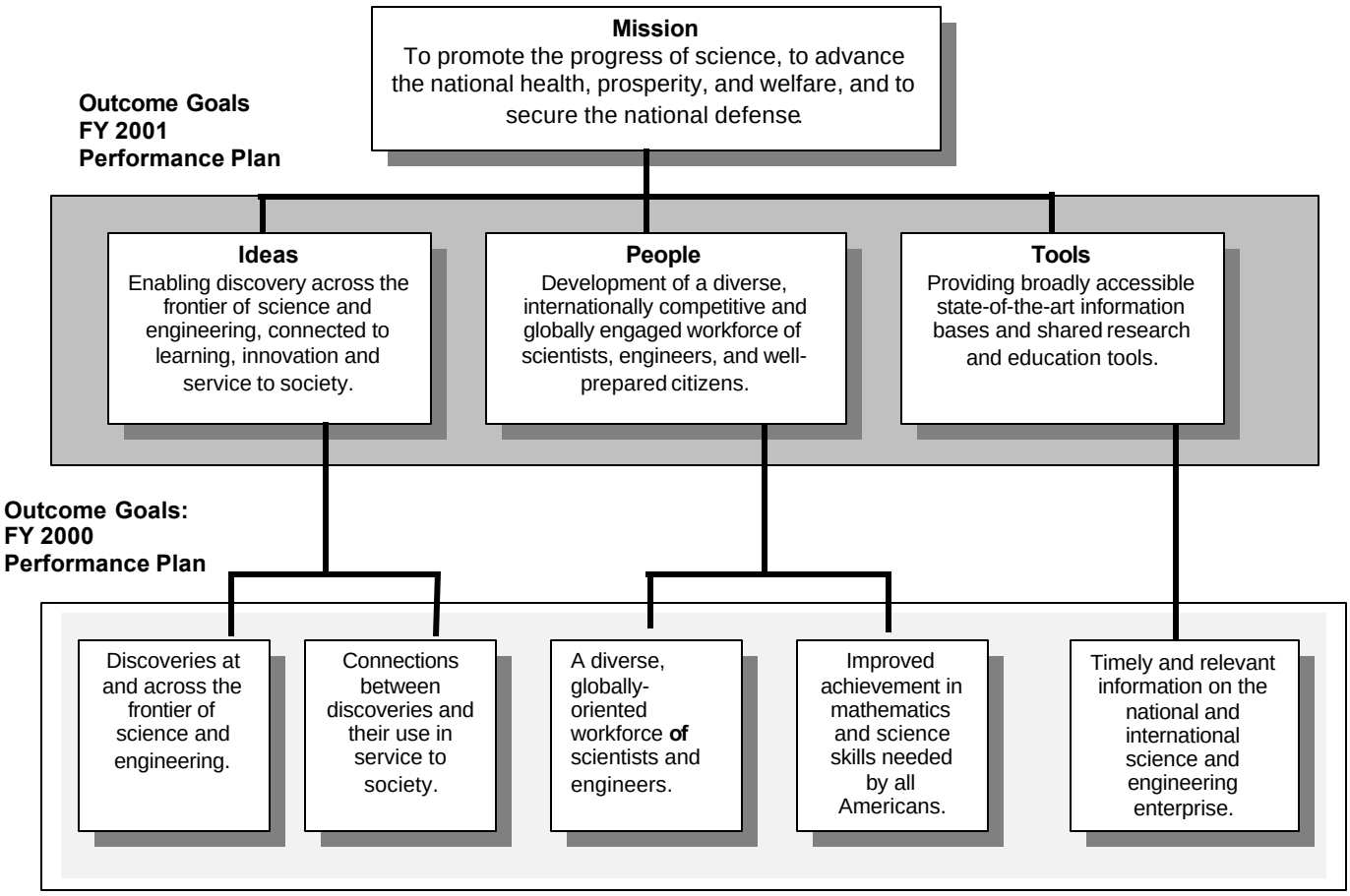
1. *Merit Review
2. Data Security
3. Cost Sharing
4. Award Administration
5. Management of Large Infrastructure Projects
6. *FastLane
7. GPRA Data Quality
8. Work Force Planning and Training
9. Management of U.S. Antarctic Program
10. *Fostering a Diverse Scientific Workforce

An "" denotes areas included as goals in the FY 2001 performance plan*

NSF continues to maintain performance goals in annual performance plans for FY 2001 and 2002 related to the use of merit review, use of FastLane, workforce training, and increasing the diversity of the scientific workforce. NSF has internal management controls which continually monitor award administration, cost sharing by awardees, data security and quality, and project management. NSF is committed to achieving and maintaining the highest standards with integrity to produce high quality outputs and outcomes, and to improving it's performance overall in these areas and others on a continuing basis.

VIII. TRANSITION TO FY 2001 AND BEYOND

The NSF FY 2001 Performance Plan is based on NSF's updated GPRA *Strategic Plan FY 2001 – 2006*, finalized in September 2000, and upon newly developed Strategic Outcomes included therein. The chart below clarifies the linkage between the new goals and those described in earlier NSF GPRA documents. The Strategic Outcome Goal areas of developing People, enabling Ideas, and providing Tools serve as the linkage between NSF's mission and annual performance goals. The FY 2001 Performance Plan goals take into account lessons learned in FY 1999 and FY 2000, strengths and weaknesses identified, recommendations from the NSF Strategic Planning Integration Group, and input from the research community, auditors, Congressional groups, and stakeholders. However, we have since learned that our performance indicators for the Outcome Goals may be too broadly-stated. Additional discussion of annual performance goals and indicators pertaining to these Outcome areas may be found in the NSF FY 2001 Performance Plan.



IX. INFORMATION ON USE OF NON-FEDERAL PARTIES

This GPRA performance report was written and prepared solely by NSF staff.

Non-Federal external sources of information used in preparing this report include:

- Reports from awardees demonstrating results.
- Reports prepared by evaluators – Committees of Visitors and Advisory Committees – in assessing NSF programs for progress in achieving Outcome Goals.
- Reports prepared by a consulting firm to assess the procedures the Foundation uses to collect, process, maintain, and report performance goals and measures.

Specific examples:

Highlights or sources of examples shown as results may be provided by principal investigators who received support from NSF.

NSF uses external committees to assess the progress of programs toward Outcome Goal achievement. External evaluators provide NSF with reports of programs, and provide feedback to NSF on a report template prepared by NSF. NSF makes use of these committee reports when assessing progress the Foundation is making towards achieving its goals. Examples are COV and Advisory Committee reports that provide an independent external assessment of NSF's performance.

NSF engaged an independent third-party (PricewaterhouseCoopers LLP) to conduct a review of data and information used in performance reporting. PwC reviewed NSF's performance data and information pertaining to its Outcome Goals, Management Goals, and Investment Process Goals. This additional independent review helped to eliminate potential reporting bias that can develop in self-assessments. It also provides assurance of the credibility of performance reporting information and results.

X. BUDGET INFORMATION

NSF obligated $3.9 billion in FY 2000. Administrative support for the Foundation was approximately 5% of the total NSF budget.

XI. CLASSIFIED APPENDICES NOT AVAILABLE TO THE PUBLIC

None to report

XII. ANALYSIS OF TAX EXPENDITURES

None to report

XIII. WAIVERS OF ADMINISTRATIVE REQUIREMENTS

None to report

XIV. APPENDIX OF ADDITIONAL EXAMPLES ILLUSTRATING OUTCOMES OF NSF INVESTMENTS

FY 2000 EXAMPLES OF ACHIEVEMENTS CITED BY EXTERNAL EVALUATORS

OUTCOME GOAL 1

DISCOVERIES AT AND ACROSS THE FRONTIER OF SCIENCE AND ENGINEERING

External evaluators cited the following examples of results from NSF awards as demonstrating success in support of Outcome Goal 1. These examples illustrate important discoveries, new knowledge and techniques, both expected and unexpected, within and across traditional boundaries; and high-potential links across these boundaries.

The examples shown illustrate NSF-supported results reported in the FY 2000 areas of emphasis for this outcome goal: balance of innovative, risky, interdisciplinary research; new types of scientific databases and tools to use them; life in extreme environments; biocomplexity; and nanoscience and engineering. It is interesting to note that many results cross the boundaries between discoveries, new knowledge, interdisciplinary research, biocomplexity, and nanoscience. The diverse portfolios of awards show potential for significant impact in these areas.

- **TRACKING TURBULENCE** Turbulent flow of fluids is important in many fields, from atmospheric sciences to combustion science to fundamental fluid physics. For example, in the design of engines, fuel combustion leads to the production of hot gases that are very turbulent. This turbulence affects the amount of fuel that is actually burned and significantly affects the efficiency of the engine and the level of pollutants it produces. Being able to measure turbulence can lead to the design of more efficient engines. A major problem is to monitor the fluid flow, which is characterized by high "Reynolds Numbers". A low Reynolds Number indicates smooth flow, and a high Reynolds Number indicates chaotic flow. Recent innovative work has begun to apply particle physics techniques and particle detectors to follow the motion of numerous small buoyant 'particles' to map out the complex turbulence patterns. In other recent work, seminal studies of turbulence over an unprecedented range of Reynolds Numbers was achieved using cryogenic helium, near its critical point of 4.5 Kelvin, a very low temperature. (A Kelvin is a measure of absolute temperature. A temperature of 0 Kelvin, equal to absolute 'zero' at which all motion of atoms and molecules would theoretically cease, would be colder than –273 degrees. Most materials would be frozen solid at much higher temperatures.) Liquid helium is the fluid of choice for ultra-high Reynolds studies because its physical properties lead to the ability of scientists to create turbulent flow at possibly the highest Reynolds Numbers in the universe, right in an

earth-bound cryostat. Turbulence studies done at very low temperatures will impact aeronautical, chemical, and mechanical engineering fields.

- Innovative adaptation of retired undersea telephone cables to establish a sea bed seismological observatory, called H2O, under 5 km (about 4.6 miles) of water in the Pacific Ocean halfway between California and Hawaii. This resource will enable detailed characterization of the Earth's mantle under the northeastern Pacific Ocean.

- In the Antarctic a high-risk, international project netted impressive results about the long-term evolution of the Antarctic climate and ice sheets, marine life, and also topography and tectonics. The recorded Antarctic changes help to explain some of the puzzling major changes in global climate on timescales of millions of years.

- The tundra regions on the Alaskan North Slope were found to have recently shifted from being sinks for greenhouse gases to being sources for these gases in winter This is important because the large regions of Arctic tundra now represent a potentially significant addition to the global greenhouse gas budget. In the Antarctic, discoveries of rapid and episodic algal blooms in the Ross Sea were linked to fluctuations in the export of carbon from the ocean surface. When extrapolated to larger spatial scales, such blooms have the potential to explain major fluctuations in atmospheric carbon dioxide concentration.

- NSF recently funded the continued development of a small, long-range, long- endurance robotic aerosonde for use in cold regions. Typically, aircraft of this type are not designed with anti-icing capabilities in order to maintain their weight and endurance characteristics. In August 2000 two weeks of flights were conducted to test new instruments, ice detectors and anti-icing coatings. The tests were highly successful and will continue with more miniature instruments, an upgraded aerosonde design and a new catapult launch device.

- An interesting example of research focused on Life in Extreme Environments is the discovery of bacteria actively metabolizing at –17°C in snow at the South Pole. This unexpected result reduces the lower temperature limit for life. This evidence for the resilience of life exposed to heavy doses of damaging ultra-violet radiation, extreme cold, and darkness has important implications for the possibility of life existing elsewhere in the Solar System.

- **NEW TYPES OF OCEAN BACTERIA THAT CONVERT LIGHT INTO ENERGY** A new strain of bacteria was recently discovered that employs bacteriorhodopsin, a protein that demonstrates light-harnessing abilities previously known only to exist in fungi and archaea. These organisms thrive in hostile environments where sustenance is scarce—like the open ocean. NSF-supported researchers found a bacteria that uses a type of

chlorophyll never before seen in open ocean bacteria. Two teams isolated DNA directly from seawater samples and compared many of the fragments to those already on file in public databases. The gene that stood out was that which codes for bacteriorhodopsin. They developed a fluorometer to search for bacteria that might use dim infrared light emitted from deep sea vents. They found none at the vents, but when scanning the surface waters they picked up many positive signals. The types of bacteria discovered by these two teams employ different mechanisms to harness light and convert it into energy. What they have in common is the ability to thrive in the open ocean where nutrients are limited and in turn provide nourishment for other organisms higher up the food chain.

- NSF-supported collaborators have developed a new biosensor based on fiber optic technology that can directly monitor microbial community structure and activities in coastal and estuarine waters and sediments. The biosensor design will allow multiple assays in the future. Such a sensor should lead to new knowledge regarding biogeochemical processes in these environments including the "relationships between cell abundance, gene expression, and actual microbial metabolic activities under different environmental conditions".

- Invaluable insights into the evolution of vertebrates have been provided by NSF-supported groups working to understand important evolutionary steps in the transition from invertebrates to vertebrates. Using comparisons of gene expression, and model vertebrates such as mice and zebrafish, these labs have provided important insights into the development of the brain, spinal cord, and neural crest. In addition, the researchers have been able to develop methods to perturb gene expression in non-model systems and have paved the way for important future studies by all researchers in the field.

- **NEW NANOWIRES** Nanoporous templates were created by exploiting the self-assembling nanoscale structure of cylindrical phase diblock-copolymers. Functional materials are deposited into the nanopores to create the final functional nanostructure. This fast and easy-to-use method was used successfully to fabricate an array of magnetic cobalt 'pillars' (or nanowires) of very high density. These may find use in new magnetic hard disks that can have 200 times the storage capacity of present commercially available disks.

FY 2000 EXAMPLES OF ACHIEVEMENTS - OUTCOME GOAL 2

CONNECTIONS BETWEEN DISCOVERIES AND THEIR USE IN SERVICE TO SOCIETY

External evaluators cited the following examples of results from NSF awards as demonstrating success in support of Outcome Goal 2. These examples made the connections between discoveries and their use in society and were rapidly and readily available and used as appropriate in education, policy development, or by other federal agencies or the private sector.

- **FIRE-WEATHER** Ongoing wildfire research supported by NSF is directed at improving the understanding of fire behavior and dynamics. This research involves collaboration with a growing number of colleagues including the U.S. Forest Service, Monash University, University of Colorado, the Country Fire Authority (CFA) of Victoria, and Australia's Northern Territories Bushier Council. The groups combine models, instrument development, and observations of forest fires and grass fires in field experiments conducted in the Northwest Territories of Canada, Australia, and the western United States to gain a better understanding of fire behavior and spread. This new knowledge helps the fire captain to better position his firefighters and equipment to fight a fire. The increased understanding of fire dynamics can help prevent firefighters from being overrun by fire and can save lives.

- **LIGHTER-WEIGHT ELECTRONICS** Consumer demand for smaller, more-reliable, lighter-weight electronic devices is a strong contributor to our nation's economic growth. One center located at Georgia Institute of Technology is helping to meet that demand. Flip-chip microelectronic packaging, the technology of attaching semiconductor chips directly to circuit cards, can deliver the needed functionality. However, costly manufacturing processes and materials have hindered wide-scale proliferation of flip-chip technology. The center has created a suite of next-generation flip-chip manufacturing processes, advanced materials, and manufacturing equipment in cooperation with their 20 industrial partners. These new methods could reduce flip-chip costs by 50-80 percent. The new materials are now commercially available from organizations such as Dexter, National Starch & Chemical, Emerson and Cuming, Loctite, and Alpha Metals. Manufacturing equipment for using these new materials is available from Cookson and Siemens. Seagate has already integrated some of the new technologies, materials, and equipment into their manufacturing lines. Large industrial organizations, whose products span the spectrum of commercial and military electronic devices, such as Advanced Micro Devices, Chrysler, Ericsson, Honeywell, Texas Instruments, Nokia, Lucent Technologies, and Northrop Grumman now are poised to implement flip-chip technologies into their next-generation of products and systems.

- **CRACKS ALONG THE CONTINENTAL SHELF** NSF-supported researchers discovered cracks along the edge of the continental shelf off the coast of Southern Virginia. The researchers suggest that the cracks could be the start of underwater landslides that could, in turn, create tsunamis. The investigators received additional support to carry out a detailed geological and geophysical investigation of these features. Initially thought to be caused by faults. The cracks appear to be depressions formed by continuous and massive blowouts of gas. The researchers maintain that such blowouts could trigger landslides and tsunamis and note that similar gas blowouts have damaged or destroyed oil rigs in the Gulf of Mexico and the North Sea. The implications of these findings are important for identifying geo-hazards on the east coast of the United States.

- **IN THE AREA OF DESIGN AND MANUFACTURING** NSF-supported researchers have been very successful in disseminating their research results to the private sector, where they have become useful tools. For example, in the areas of rapid prototyping and rapid fabrication, there have been spin-offs significant for commercial ventures. NSF research resulted in patented technology licensed to DTM Corporation. Subsequently, DTM developed and manufactured the Sinterstation 2500® System. The Sinterstation 2500® is a commercially successful rapid prototyping technology used in US European university and government research laboratories, including Sandia and Los Alamos National Laboratories and the Jet Propulsion Laboratory, and in several large corporations, including The Gillette Company. A 3D Printing technology was licensed to several companies, all of whom have used the technology to manufacture a wide variety of products. Several large companies have options for licenses in place. Both of these technologies have led to significant reductions in the time from design to manufacture. A further effect of this reduction in lead time is the potential to diminish the need to maintain large spare-parts inventories, particularly in Department of Defense applications.

- **NSF-SUPPORTED PROJECTS ON THE NSFNET** developed new techniques in cross vendor route registry and its management. The major activities include advancement of Internet routing algorithms with respect to scaling and stability issues, routing information registration and dissemination for the network service providers serving the Internet, deployment of route servers to aid in the dissemination and real time maintenance of the global Internet routing system, and coordination and sharing of technical information in support of the Internet operation community. Several leading vendors have licensed routing algorithms developed by this project.

- **GLOBAL SHARING OF SCIENCE RESULTS** E-print Archives, the electronic-print system, allows physicists to post the results of their research in a timely manner on the web, allowing other scientists to have rapid access to their work as important discoveries are made.

- **IMPROVING EFFICIENCY OF NETWORK DESIGN TO SAVE TIME AND MONEY** Solving problems in local access and network layout are fundamental to optimizing computation. NSF-supported work addresses some fundamental issues in the area of network design with practical relevance since small improvements in network layout can translate into savings of many millions of dollars. The NSF-supported research has resulted in solutions and associated software packages capable of solving network design orders-of-magnitude faster on available computers. The work applies methods from operations research to networking problems, and has already received recognition from the operations research community. It will have substantial impact on network service providers.

NSF awards produced a wide variety of important discoveries in both the Arctic and Antarctic. Many discoveries concern regional environmental change which have implications for global climate change.

- Greenland ice core studies have produced evidence that rapid climate change – 8 degrees C in less than a decade – has occurred.
- Studies have shown that the sea ice cover of the Arctic Ocean has undergone a major decrease in the past decade as a result of melting and redistribution due to atmospheric circulation changes.

Protection of the environment and human health in a context of continual development and economic growth is perhaps the most significant global challenge for the next millennium. Issues such as sustainability, pollutant avoidance, and remediation drive the direction of many NSF investments. NSF programs continue to participate substantially in the NSF/EPA initiative, "Technology for a Sustainable Environment". Other notable NSF-supported programs include studies on environmentally-benign processing, development of environmentally-safe products, destruction methods for pollutants, and diagnostics of known carcinogens. Recent fundamental breakthroughs under NSF support in clean chemistry, diagnostics, and new concept development show the promise of minimizing/controlling emissions and improving our quality of life.

- NSF supported researchers have demonstrated the use of high pressure carbon dioxide (super critical conditions) as a solvent for cleaning clothes, computer parts, and textiles. This technology has the potential for replacing organic and halo-carbon solvents. They are the principal pollutants in the cleaning industry. The NSF- supported fundamental science has led to the creation of a small business and a center of study at North Carolina universities.

- Simultaneous reduction of nitric and nitrous oxide (NOx) and soot emissions from practical combustion systems to meet tight emission standards is an extreme challenge due to competing formation/destruction processes. NSF-supported researchers have developed a catalytic filter for diesel engines that captures soot particulates formed

during low temperature operation and then oxidizes this soot to reduce NOx emissions under high temperature conditions.

- **IMPACT ON THE DEVELOPMENT AND MANUFACTURE OF SPECIALTY CHEMICALS, NOVEL MATERIALS AND BIO-BASED AGENTS** Our ever-rising standard of living is accompanied by an ever-increasing demand for better and more affordable specialty chemicals, novel materials, and chemical/biological therapeutic agents. The production of these chemicals and materials requires highly sophisticated, and often prohibitively expensive, reaction processes and/or separation and purification steps. Advances made with support from NSF have greatly contributed to the technological developments in these areas.
  - NSF-supported development of a low-cost technique to use immobilized affinity chromatography to separate valuable blood proteins such as protein C, prothrombin and vitamin K-dependent proteins from plasma was developed. These natural plasma proteins are much more effective than those derived from currently available recombinant DNA technology. This work is closely coordinated with and done in collaboration with the American Red Cross.

- NSF awards frequently result in application software, patents, and an educational exchange between academic researchers and industry engineers. Researchers learn about the domain and adapt their research agendas to industrial needs. Industry engineers have access to recent research results and course materials and, as the relationship progresses, access to a pool of potential employees skilled in the domain. A few examples that highlight these connections are:
  - NSF engineers in partnership with apparel manufacturer Levi-Strauss, have developed and implemented an adaptive, closed-loop production control system. Thanks to a donation of equipment from a factory being closed by Levi-Strauss, a production line identical to an operating line at another factory was installed in the engineer's laboratory space, allowing a rigorous comparison of the traditional and proposed lines. The research has helped the manufacturer to supply quantities of a large mix of products rapidly and economically while maintaining minimal surge capacity to meet occasional peak demands.
  - A tricycle "cobot" for removing doors from newly painted automobiles prior to assembly of the cabin has been developed with NSF support. On the basis of this research prototype, General Motors developed a rugged, highly maneuverable device for this task. The cobot is patented. Various educational courses were provided to GM engineers.

Science and Technology Centers (STCs): Integrative Partnerships have responsibilities in the area of knowledge transfer that go beyond those of individual investigators by design. The first new set of STC awards in almost a decade were made in FY 2000. Assessments address both the effectiveness of existing centers in establishing connections and the potential for strong performance in the new class.

- One Science and Technology Center is dedicated to exploiting the atmospheric conditions at the South Pole to do astronomy and cosmology. The Center also has an active program of education and outreach. The core program, Space Explorers, targets African-American students at inner-city high school students in Chicago to enhance their science abilities before they enter college. Each August, thirty students attend a week-long summer residential institute at Yerkes Observatory. A 2-day version of the summer institute is given each December. The Space Explorers teach in grammar schools during the academic year. Space Explorers and Adler Planetarium astronomers present programs using a portable planetarium to 30 schools, reaching nearly 3,000 students, annually.

- NSF-supported research in cognitive science has focused on the cognitive aspects of language acquisition, structure and processing, logic and computation, and perception and action. Recent accomplishments include progress on the integration of research on language acquisition with statistical learning theory, simulations of language learning, and online methods to study children's language acquisition.

FY 2000 EXAMPLES OF ACHIEVEMENTS - OUTCOME GOAL 3

A DIVERSE, GLOBALLY-ORIENTED WORKFORCE OF SCIENTISTS AND ENGINEERS

External evaluators cited the following examples of results from NSF awards as demonstrating success in support of Outcome Goal 3. Noteworthy examples taken from committee reports have been selected to demonstrate results in FY 2000 areas of emphasis that include integrative research and education opportunities, and participation of under-represented groups in integrative research and education.

- **LIVING IN A GLOBAL WORLD** NSF programs are at the forefront of study of the emerging area of globalization. Increased economic, technological, and social interconnections among nations have resulted in new transnational, international, and supranational legal practices. Our increasingly global world calls for continued development and innovation of legal theories. Several NSF funded projects have already made significant findings on new forms of global law and global legal processes. Studies have examined and explored
  - the quality of the practice of law internationally by looking at lawyers' roles in social movements and human rights campaigns;
  - international networks of lawyers to understand how the practice of law and experience of practitioners have changed in response to global processes;
  - the new culture of finance, which draws on innovative methodology such as monitoring an internet discussion group.

- **INCREASING STUDENTS' EXPOSURE TO QUANTITATIVE DATA AND EMPIRICAL ANALYSIS** The principle purpose of the American National Election Study (ANES), has been the development of high-quality data on public opinion and political choice in American national elections. With a history of support spanning 25 years, the data generated by this enterprise increasingly is used in college and even in high school texts, not only to inform students about elections and voting, but also to teach them the rudiments of data analysis and statistics. Because American government is a required course at the college level in many state universities, all students, not just those interested in Political Science, are exposed to quantitative data and empirical analysis. Frequently ANES data on diskette are now included in introductory American government textbooks, along with basic statistical software, and lesson plans include suggestions for the effective integration of these data in courses.

- NSF support at the University of Hawaii provides widely distributed educational kits that undergraduate students use to effectively learn how to design low cost, complex systems. The kits consist of a prototyping card, with network capability, in a book with companion materials. There is a strong team involving researchers at the University of Hawaii, several industrial organizations, and a publisher. The kit is in accordance with the emphasis on design in the new Accreditation Board for Engineering and Technology

(ABET) accreditation requirements and is expected to make a significant impact in undergraduate education in engineering and science.

- NSF support to a researcher at the University of Maine has led to the development of an outreach program that supplements research on geospatial databases. Work covered by this project is part of a high school outreach program called "Spatial Horizons". The program is typically attended by more than 100 high school students per year. Another high school outreach program affected by this project is the University of Maine organized "Expanding your Horizons" program. It is targeted at female high school students attempting to increase their participation in science and engineering disciplines. The lead researcher on this project won the 1998 Outstanding Young Faculty Research Award at the University of Maine and the 1999 Presidential Citation of the American Society for Photogrammetry & Remote Sensing.

- **DEVELOPING AN ENVIRONMENT FOR THE WORKFORCE** NSF support to Mississippi State University has led to the development of methodologies for enabling industry to better accommodate disabled employees. Specifically this work targets persons with paraplegic and/or visual disabilities. It should lead to the development of an intelligent computer system to assist in making decisions associated with designing and retrofitting work tasks and the workplace to accommodate persons with disabilities. It may also address some of the major problems associated with the high unemployment rate of persons with disabilities.

- **RESEARCH EXPERIENCES FOR UNDERGRADUATES (REU)** One mechanism NSF uses to increase support for under-represented groups is the REU site award. Participation in REU sites frequently includes high percentages of under-represented groups. For example, one NSF organization has invested in over 200 REU sites. One NSF division provides resources for 60 REU sites in 33 states and Puerto Rico, with about 550 students supported at these sites. Typically, half the participants are female, and over 16% are from under-represented minority groups.

- With funding from some 24 NSF-supported centers, about 370 undergraduates participated in research activities. The undergraduates included 145 females and more than 100 minority students. Outreach to Native Americans is a focus of two of the centers.

- NSF administers the four-year undergraduate and graduate program Significant Opportunities in Atmospheric Research and Science (***SOARS***) to provide education and research opportunities in the atmospheric sciences to students from under-represented groups. Typically, about 20 students worked with scientific mentors from NSF supported labs, DOE and NASA laboratories, the University of Colorado, and other national and international universities.

- An NSF program funds a collaboration between the University of Pittsburgh and the Carnegie Museum of Natural History, in which minority high school students serve as interns, working on web-site development, exhibit and seminar development, and as museum docents. All of this is in connection with Earth science museum exhibits. The internships target African-American students interested in math and science in the Pittsburgh area.

FY 2000 EXAMPLES OF ACHIEVEMENTS - OUTCOME GOAL 4

IMPROVED ACHIEVEMENT IN MATHEMATICS AND SCIENCE SKILLS NEEDED BY ALL AMERICANS

External evaluators cited the following examples of results from NSF as demonstrating success for Outcome Goal 4. Noteworthy examples taken from committee reports have been selected to demonstrate results in FY 2000 areas of emphasis, which include K-12 systemic activities; research on learning and education; graduate teaching fellows in K-12 education; and K-16 digital libraries.

NSF considers many of the K-12/16 activities listed to be of interest to students in order to engage them at an early stage in their education in science, mathematics and computer science. Early involvement is extremely important to retaining students in science and engineering in the future. Educating in science is educating for the future.

- Research on learning has provided important findings for middle and high school. At Rutgers University a longitudinal study of the development of proof-making in students has found that students at the middle school and high school level are capable of much more advanced mathematical thinking than expected. For example, although high school students did not use the symbolic representation or procedures of college students studying calculus, they developed powerful and correct solutions to calculus-type problems.

- Hampshire College found that students enrolled in inquiry-based classes performed better on essay style assessments of general scientific reasoning in comparison to students in more traditional classes.

- NSF supports a focused project on "at-risk" students at the Kieffer Institute for Development of Science-based Education, entitled "Science: Day-by-Day, Life-by-Life, Community-by-Community". The goal of the project is to formulate an Earth-science-based curriculum for K-12 education for at-risk students. At-risk students are defined as any group of students who are not able to participate in a continuous K-12 curriculum. The curriculum uses the Earth sciences to capture students' interests and to stimulate learning in other fields such as mathematics, social sciences, and language arts.

- Pre-service and in-service science teachers work together in NSF-supported research projects at Towson State. This teaming of experienced teachers with teachers-in-training facilitates the acquisition of important new expertise, the development of a deeper understanding of research, and the unique opportunity to share invaluable experience. By targeting both active and developing science teachers, the benefits of this experience will be rapidly and widely distributed to K-12 students.

- Critical to the goal of science education for all Americans is the development of creative ways of reaching the public. Support for museum collections promotes this goal in a number of ways. Museum displays and the computerization of collections and distribution of data over the World Wide Web provide broad accessibility to the American public. Equipment supported by NSF and placed in museums often becomes the focus of education-related activities. Museums are also involved in web-based science and education programs that are directly related to supported collections.

- NSF-supported researchers at the University of Massachusetts are studying ways to improve the abilities of K-12 students to find, evaluate, and organize information available on the Internet. These skills comprise a significant subset of the Information Literacy skills that Library Science teaches. The approach consists of building a Web search interface in which Information Literacy skills are matched to Information Retrieval (IR) tools in a way that teaches skills while helping students locate information on the Internet. Improved queries are created from the student's information need, supporting information from the surrounding educational environment, and query expansion from educationally-focused databases. Information filtering techniques identify, and if desired eliminate, retrieved information at the wrong grade-level or containing inappropriate content. One of the goals is to establish a long-term research relationship to address the use of information technology and the Internet in K-12 education.

- NSF supported collaborators at Carnegie Mellon have supported development of a computer based reading tutor for elementary school students. An early evaluation showed rapid improvement in reading skills among poor readers.

- **QUARKNET** partners high school physics teachers and their students with particle physics research groups at 60 U.S. universities and laboratories. Students learn fundamental physics, investigate particle physics through live, online data and collaborate with other students worldwide. About 25 teachers complete summer research appointments and these teachers go on to offer workshops to another hundred teachers. Each teacher who has skills and knowledge enhanced in such research experiences then communicates that knowledge and excitement to all of the students in his or her classroom.

- Recent results from research on the learning of science and mathematics have shown that elementary school children are capable of more sophisticated forms of reasoning, modeling, and higher order learning that previously thought or that are currently embedded in teaching materials and teaching practice:
  - Homeless students and Latino students for whom English is a second language, or whose command of English is still limited, do learn to high national standards when properly taught.

- Fourth and fifth graders can talk appropriately about sampling and distributions and how these ideas can help explain the growth of organisms and populations of organisms.
- Research projects constructed by elementary school students reveal understanding of experimental controls and extraneous variables even at the first grade level.

- NSF has actively supported research in Digital Libraries since 1994. The research has made major strides in developing techniques to advance digital technologies for searching, indexing and storing objects beyond traditional text. For example:
  - The e-skeletons project enables students to study comparative anatomy of humans and baboons (gorillas are coming soon!). With low cost 3-D printing equipment schools can supplement high resolution images with 3-D copies of bones that otherwise would be unavailable for most schools and colleges. (See http://www.eskeletons.org)
  - Digital library research in the humanities for the Perseus Digital Library extends access to a wide range of unique museum materials to students and scholars. A timely presentation on the Greek Olympics showed vases and also referenced text material.

- School children, with the help of staff at the University of Colorado, are able to sample current and fossil remains of a particular gastropod throughout its historical range. They do this in order to explain outstanding problems in predator/prey relationships through geologic history.

- Several hundred volunteer observers, ranging in age from 6 to 80, have been trained to make rain and hail observations across the state of Colorado. Rain and hail patterns are mapped daily, disseminated to students, businesses, government and scientists, and used by the National Weather Service, the local mosquito control program, and community water conservation programs.

- The Lawrence Hall of Science has developed Student Radon Research Kits, that contain all of the equipment necessary for secondary school students to conduct radon and meteorological research at school sites.

- UCLA geoscientists have developed "Geoscience Interactive Simulations for Teaching (GIST)," student-controlled numerical simulations of Sun-Earth interactions.

- The IRIS Consortium has developed a museum display and educational materials that bring research quality seismograph data to the public to help understand earthquakes and the role they play in shaping our dynamic Earth.

- **THE *WORLDWATCHER* CURRICULUM: INTEGRATING VISUALIZATION INTO INQUIRY-BASED SCIENCE LEARNING** explores use of cutting-edge scientific visualization as a teaching tool in middle school and high school classrooms. This effort has received an A+ by *Education World*. The *WorldWatcher* website includes revolutionary and downloadable scientific visualization environment software. Students engage in inquiry-based learning, exploring, creating, and analyzing scientific data.

- **THE ALTERNATIVES FOR REBUILDING CURRICULA** (ARC) is a center promoting awareness and effective use of the elementary mathematics curricula: *Math Trailblazers*, *Investigations in Number, Data, and Space*, and *Everyday Mathematics*. The release of these curricula is relatively recent, but they are making determined inroads to the market. In 1998, these NSF-supported programs were used in about 3% of the nation's school districts; adoptions and large pilot tests have nearly doubled each year. Currently, the curricula are being used by almost 2,600,000 students in about 11% of the 14,000 school systems in the country.

XV. SCHEDULE OF PROGRAM EVALUATIONS

The following table provides information on the scheduling of meetings for Committees of Visitors (COVs) for FY 1999, FY 2000, and FY 2001. Note that the schedule and program titles shown are actual for FY 1999, FY 2000, and tentative for FY 2001. A COV may not be scheduled in this 3-year period of the program was new in FY 2000. Programs that are new in FY 2001 will not appear on this list. Committee of Visitor reports will be made available to the public electronically in December, 2001. NSF anticipates that COV reports will become electronically available in July, of subsequent years.

COMMITTEE-OF-VISITOR SCHEDULE FOR FY 1999-2000-2001

Division (Program)	**FY 1999**	**FY 2000**	**FY 2001**
Biological Infrastructure			
Instrument Related Activities		X	
Research Resources	X	X	
Training	X	X	
Plant Genome			X
Environmental Biology			
Ecological Studies	X		
Systematic and Population Biology	X	X	
Integrative Biology and Neuroscience			
Neuroscience	X		
Developmental Mechanisms		X	
Physiology and Ethology			
Molecular and Cellular Biosciences			
Genetics	X		
Biomolecular Structure and Function		X	
Cell Biology			X
Biomolecular Processes		X	
Advanced Computational Infrastructure and Research			
Advanced Computational Research		X	
Partnerships for Advanced Computational Infrastructure (PACI)			
Computer – Communications Research			
Theory of Computing		X	
Computer Systems Architecture		X	
Numeric, Symbolic, & Geometric Computation		X	
Software Engineering and Languages		X	
Operating Systems and Compilers		X	
Design Automation		X	
Communications		X	
Signal Processing Systems		X	

COV SCHEDULE FOR FY 1999-2000-2001

Division (Program)	**FY 1999**	**FY 2000**	**FY 2001**
Advanced Networking Infrastructure and Research			
Advanced Networking Infrastructure		X	
Special Projects in Networking Research		X	
Networking Research		X	
Information and Intelligent Systems			
Computational and Social Systems	X		
Information and Data Management	X		
Robotics and Human Augmentation	X		
Human Computer Interaction	X		
Knowledge and Cognitive Systems	X		
Experimental and Integrative Activities			
Infrastructure			
Minority Institutions Infrastructure			X
Advanced Distributed Resources for Experiments			X
Instrumentation Grants for Research	X		X
Research Infrastructure			X
Research			
Experimental Partnerships			X
Digital Government			X
Next Generation Software			X
Education			
CISE Educational Innovation			X
Education System Reform			
Statewide Systemic Initiatives			X
Urban Systemic Initiatives	X		X
Rural Systemic Initiatives			X
Urban Systemic Program			
EPSCoR		X	
Elementary, Secondary, & Informal Education			
Informal Sci Education			X
Teacher Enchancement		X	
Presidential Awards for Excellence in Mathematics		X	
Instructional Materials Development			
Undergraduate Education			
Course, Curriculum, and Laboratory Improvement		X	
Teacher Preparation		X	
Advanced Technological Education		X	

COV SCHEDULE FY 1999-2000-2001 (CONT.)

Division (Program)	**FY 1999**	**FY 2000**	**FY 2001**
Graduate Education			
Graduate Research Fellowships	X		
NATO Postdoc Fellowships			X
IGERT			
PFSMETE			
GK-12 Fellows			
Human Resource Development			
The Louis Stokes Alliances for Minority Participation			X
CREST			X
Program for Gender Equity in SMET		X	
Programs for Persons with Disabilities		X	
Alliances for Grad. Ed. and the Professoriate (AGEP)			X
HBCU			X
Research, Evaluation & Communications			
REPP/ROLE			
Evaluation		X	
Bioengineering and Environmental Systems			
Biochemical Engineering	X		
Biotechnology	X		
Biomedical Engineering	X		
Research to Aid the Disabled	X		
Environmental Engineering			
Environmental Technology			
Ocean Systems			
Civil and Mechanical Systems			
Dynamic System Modeling, Sensing, and Control	X		X
Geotechnical and GeoHazard Systems	X		X
Infrastructure and Information Systems	X		X
Solid Mechanics and Materials Engineering	X		X
Structural Systems and Engineering	X		X
Network for Earthquake Engineering Simulation			X
Chemical and Transport Systems			
Chemical Reaction Processes		X	
Interfacial, Transport, & Separation Processes		X	
Fluid and Particle Processes		X	
Thermal Systems		X	

COV SCHEDULE FOR FY 1999-2000-2001 (CONT.)

Division (Program)	**FY 1999**	**FY 2000**	**FY 2001**
Design, Manufacture & Industrial Innovation			
Operations Research & Production Systems		X	
Design and Integration Engineering		X	
Manufacturing Processes & Equipment		X	
Innovation and Organizational Change		X	
Grant Opportunities for Academic Liason w/Industry		X	
SBIR			X
Small Business Technology Transfer		X	X
Electrical & Communication Systems			
Electronics, Photonics, and Device Technologies		X	
Control, Networks, and Computational Intelligence		X	
Engineering Education & Centers			
Engineering Education			X
Human Resource Development			X
Engineering Research Centers			X
Earthquake Engineering Research Centers			X
Industry/Univ Coop Res Centers			X
Combined Research-Curriculum Development			X
Supplement Support for Women, Minorities and Phys. Disabled			X
Geo-wide Education & Human Resources		X	
Atmospheric Sciences			
Atmospheric Chemistry			X
Climate Dynamics			X
Meoscale Dynamic Meteorology			X
Large-Scale Dynamic Meteorology			X
Physical Meteorology			X
Paleoclimate			X
Magnetospheric Physics	X		
Aeronomy	X		
Solar Terrestrial Research	X		
Upper Atmospheric Research Facilities	X		
NCAR/UCAR		X	
Lower Atmospheric Observing Facilities		X	
UNIDATA		X	

COV SCHEDULE FY 1999-2000-2001 (CONT.)

Division (Program)	**FY 1999**	**FY 2000**	**FY 2001**
Earth Sciences			
Instrumentation and Facilities			X
Tectonics			
Geology and Paleontology			
Hydrological Sciences			
Petrology and Geochemistry			
Continental Dynamics			
Geophysics			
Ocean Sciences			
Oceanographic Technical Services			
Ship Operations			
Oceanographic Facilities			
Ocean Drilling			
Marine Geology and Geophysics	X		
Biological Oceanography	X		
Chemical Oceanography	X		
Physical Oceanography	X		
Oceanographic Tech. & Interdisciplinary Coordination	X		
Astronomical Sciences			
Extragalactic Astronomy and Cosmology	X		
Advanced Technologies & Instrumentation	X		
Planetary Astronomy	X		
Stellar Astronomy & Astrophysics	X		
Electromagnetic Spectrum Management	X		
Galactic Astronomy	X		
Education, Human Resources & Special Programs	X		
National Astronomy & Ionosphere Center (NAIC)	X		
National Optical Astronomy Observatories (NOAO)	X		
National Radio Astronomy Observatory (NRAO)	X		
Gemini 8-Meter Telescopes	X		
University Radio Facilities	X		

COV SCHEDULE FY 1999-2000-2001 (CONT.)

Division (Program)	**FY 1999**	**FY 2000**	**FY 2001**
Chemistry			
Analytical & Surface Chemistry			X
Chemistry Research Instrumentation & Facilities (CRIF)			X
Inorg, Bioirnorg, & Organometallic Chemistry			X
Organic & Macromolecular Chemistry			X
Experimental Physical Chemistry			X
Office of Special Projects			X
Organic Chemical Dynamics			X
Organic Synthesis			X
Theoretical and Computational Chemistry			X
Chemistry of Materials			X
Materials Research			
Condensed Matter Physics	X		
Materials Theory	X		
Metals, Ceramics, & Elect. Materials	X		
Solid-state Chemistry and Polymers	X		
National Facilities & Instrumentation	X		
Materials Research Sci. & Eng. Centers	X		
Mathematical Sciences			
Statistics and Probability			X
Geometric Analysis			X
Algebra & Number Theory			X
Applied Mathematics			X
Infrastructure			X
Analysis			X
Computational Mathematics			X
Topology and Foundations			X
Physics			
Atomic, Molecular, Optical and Plasma Physics		X	
Elementary Particle Physics		X	
Gravitational Physics		X	
Nuclear Physics		X	
Theoretical Physics		X	
Particle and Nuclear Astrophysics			
Education and Interdisciplinary Research			
Major Research Instrumentation		X	
Science and Technology Centers			

COV SCHEDULE FOR FY 1999-2000-2001 (CONT.)

Division (Program)	**FY 1999**	**FY 2000**	**FY 2001**
Polar Research Support			X
Antarctic Sciences			
Antarctic Aeronomy and Astrophysics		X	
Antarctic Biology and Medicine		X	
Antarctic Geology and Geophysics		X	
Antarctic Ocean and Climate Systems		X	
Antarctic Glaciology		X	
Arctic Sciences			
Arctic System Sciences		X	
Arctic Social Sciences		X	
Arctic Natural Sciences		X	
Arctic Research Support and Logistics		X	
International Programs	X		
Social, Behavioral, and Economic Research			
Economics		X	
Decision, Risk, and Mgt. Sciences		X	
Innovation and Organizational Change		X	
Cultural Anthropology	X		
Physical Anthropology	X		
Archeology & Archaeometry	X		
Geography & Regional Science	X		
Sociology		X	
Political Science		X	
Law & Social Issues		X	
Methodology, Measurement & Statistics		X	
Society Dimensions of Engineering, Science, and Technology		X	
Science, Technology, and Society		X	
Linguistics	X		
Human Cognition & Perception	X		
Social Psychology	X		

XVI. TABLE OF ACRONYMS

ACRONYM	DEFINITION
ABET	Accreditation Board for Engineering and Technology
AC	Advisory Committee
ACM	Association for Computing Machinery
ACSI	American Customer Satisfaction Index
AGI	Arabidopsis Genome Initiative
ARPANET	Advanced Research Projects Agency Network
ATM	Atmospheric Sciences
BART	Bay Area Rapid Transit
BBC	British Broadcasting Corporation
BGE	Baltimore Gas and Electric?
BIO	Biological Sciences
CARA	Center for Astrophysics Research in Antarctica
CAREER	Faculty Early Career Development Program
CCR	Computer-Communications Research
CETP	Collaboratives for Excellence in Teacher Preparation
CFA	County Fire Authority
CHE	Division of Chemistry
CIA	Central Intelligence Agency
CISE	Computer and Information Science and Engineering
CMB	Cosmic Microwave Background
CMU	Carnegie Mellon University
COV	Committee of Visitors
CREST	Centers of Research Excellence in Science and Technology
CRS	Congressional Research Service
CS&E	Computer Science and Engineering
CSNET	Computer Science Network
CTS	Chemical and Transport Systems
DARPA	Defense Advanced Research Projects Agency
DBI	Biological Infrastructure
DMII	Design, Manufacture, & Industrial Innovation
DMP	Distributed Mentor Project
DOE	Department of Energy
ECS	Electrical and Communications Systems
EEC	Engineering Education and Centers
EHR	Education and Human Resources
EIA	Experimental and Integrative Activities
ENG	Engineering
EPA	Environmental Protection Agency
EPSCoR	Experimental Program to Stimulate Competitive Research
ERC	Engineering Research Centers
ESIE	Elementary, Secondary and Informal Education
ESR	Educational System Reform
FBI	Federal Bureau of Investigation
FCSM	Federal Committee of Statistical Methodology

FEC	Forward Error Correction
FFRDC	Federally-Funded Research and Development Center
FY	Fiscal Year
GAO	General Accounting Office
GEO	Geosciences
GIST	Geoscience Interactive Simulations for Teaching
GPA	Grade Point Average
GPRA	Government Performance and Results Act (of 1993)
GRT	Graduate Research Traineeships
HBCU	Historically Black Colleges and Universities
HHS	Health and Human Services
HRD	Human Resource Development
I/UCRC	Industry University Cooperative Research Centers
IBM	International Business Machines
IBN	Integrative Biology and Neuroscience
IEEE	Institute of Electrical and Electronics Engineers
IG	Inspector General
IGERT	Integrative Graduate Education and Research Training
IIS	Information and Intelligent Systems
IR	Information Retrieval
IRIS	Information, Robotics, and Intelligence Systems
ITR	Information Technology Research
K-12	Kindergarten through twelfth grade
K-16	Kindergarten through college
KMPG LLC	(accounting firm)
LEARN	Laboratory Experience in Atmospheric Research
MCB	Molecular and Cellular Bioscience
MIT	Massachusetts Institute of Technology
MPS	Mathematical and Physical Sciences
MRI	Major Research Instrumentation Program
NAEP	National Assessment of Educational Process
NAPA	National Academy of Public Administration
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NEC	Nippon Electric Corporation?
NIST	National Institute for Science and Technologies
NOAA	National Oceanic and Atmospheric Administration
NSB	National Science Board
NSF	National Science Foundation
NSFNET	National Science Foundation Network
OCE	Ocean Sciences
OIA	Office of Integrative Activities
OIG	Office of the Inspector General
OLPA	Office of Legislative and Public Affairs
OMB	Office of Management and Budget
ONR	Office of Naval Research
OPP	Office of Polar Programs
PACI	Partnerships for Advanced Computational Infrastructure
PAT	Program Announcement Template
PFSMETE	Postdoctoral Fellowships in Science, Mathematics, Engineering and Technology Education

PI	Principal Investigator
POL SCI	Political Sciences
PRS	Project Reporting System
PwC	PricewaterhouseCoopers
R&D	Research and Development
REU	Research Experiences for Undergraduates
RUI	Research in Undergraduate Institutions
S&E	Salary and Expenses
SBE	Social, Behavioral, and Economic Sciences
SBIR	Small Business Innovation Research Program
SGER	Small Grants for Exploratory Research
SHEBA	Surface Heat Budget of the Arctic Ocean Project
SMET	Science, Mathematics, Engineering and Technology
SOARS	Significant Opportunities in Atmospheric Research and Science
SOC	Sociology
SRC	Semiconductor Research Corporation
SRS	Science Resource Studies
SSI	Statewide Systemic Initiative Program
STC	Science and Technology Center
TAAS	Texas Assessment of Academic Skills
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TE	Teacher Enhancement
UCAR	University Corporation for Atmospheric Research
UCLA	University of California at Los Angeles
UCSC	University of California at Santa Cruz
UCSD	University of California at San Diego
UNIDATA	UNIDATA (previously University Data Systems)
USGS	U.S. Geological Survey
USI	Urban Systemic Initiative
VBNS	Very High Speed Backbone Network Service
Y2K	Year 2000

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