II. DETAILED PERFORMANCE INFORMATION

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EXECUTIVE SUMMARY

This report, prepared pursuant to the Government Performance and Results Act (GPRA) of 1993, covers activities of the National Science Foundation during Fiscal Year 2004. A general discussion of NSF's performance assessment activities is also provided in the Management's Discussion and Analysis under "Performance Highlights," which begins on page I-15.

NSF's annual goals fall into two broad areas: "Strategic Outcome Goals" and "Other Performance Goals."

Strategic Outcome Goals: NSF's strategic plan, adopted in the fall of 2003, included a new programmatic framework that translated into four strategic outcomes goals. These goals are: People, Ideas, Tools and Organizational Excellence. People, Ideas and Tools concern the practical, concrete, long-term results of NSF's grants and programs. These goals represent the outcomes from NSF investments in science and engineering research and education. The strategic outcome goal of Organizational Excellence ensures that NSF is a capable and responsive organization that can accomplish its other strategic outcome goals.

Other Performance Goals: These goals include performance measures included in NSF's Performance Assessment Rating Tool (PART) evaluation as well as goals addressing award size, duration and dwell time related to the effectiveness and efficiency of the agency's activities.

FY 2004 Performance Results	
Number of Goals Achieved	
Annual Performance Outcome Goals	**4 of 4 (100%)**
Other Annual Performance Goals	**23 of 26 (88%)**
TOTAL	**27 of 30 (90%)**

FY 2004 Results: For FY 2004 NSF met 27 (90%) of our 30 goals.[1]

Outcome Goals: NSF was successful for all (100%) of our four annual performance goals associated with our strategic outcome goals. Our strategic outcome goals are:

People – A diverse, competitive, and globally engaged U.S. workforce of scientists, engineers, technologists and well-prepared citizens;

Ideas – Discovery across the frontier of science and engineering, connected to learning, innovation and service to society;

Tools – Broadly accessible, state-of-the-art S&E facilities, tools, and other infrastructure that enable discovery, learning, and innovation; and

[1] IBM Business Consulting Services provided an independent verification and validation of performance information and data.

Organizational Excellence – An agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices.

Examples of accomplishments for each of the outcome goals are provided within the body of the report.

<u>*Other Performance Goals:*</u> We were successful for 23 of our other 26 performance goals (88%). Our goals in FY 2004 relative to FY 2003 goals were to:

- Increase the number of U.S. students receiving fellowships through Graduate Research Fellowships (GRF) and Integrative Graduate Education and Research Traineeships (IGERT) (Goal 2). The number of students receiving fellowships increased from 3328 in FY 2003 to 3681 in FY 2004.
- Increase the stipend level for GRF and IGERT awards (Goal 3). We achieved a stipend level of $30,000 compared to $27,500 in FY 2003.
- Increase the number of applicants for Graduate Research Fellowships (GRF) from groups that are underrepresented in the science and engineering workforce (Goal 4). Our number of applicants increased from 820 in FY 2003 to 1009 in FY 2004.
- Increase the number of applications for Faculty Early Career Development Program (CAREER) awards from investigators at minority-serving institutions (Goal 5). We had 82 applications in FY 2004 compared to 67 applications in FY 2003.
- Increase the percent of Nanoscale Science and Engineering (NS&E) proposals with at least one female PI or Co-PI to 25% (Goal 6). We achieved 26% compared to 22% in FY 2003.
- Increase the percent of Information Technology Research (ITR) proposals with at least one female Principal Investigator (PI) or Co-PI to 25% (Goal 7). Twenty-nine percent of the proposals satisfied this criterion compared with 26% in FY 2003.
- Maintain the percent of Information Technology Research (ITR) proposals with at least one minority PI or Co-PI at 7% (Goal 9). We achieved 9% in FY 2004 compared to 7% in FY 2003.
- Maintain the percent of Nanoscale Science and Engineering (NS&E) proposals that are multi-investigator proposals at 75% (Goal 10). We achieved 80% in FY 2004 compared to 73% in FY 2003.
- Maintain the percent of Information Technology Research (ITR) proposals that are multi-investigator proposals at 50% (Goal 11). We achieved 62% compared to 59% in FY 2003.
- Continue to be on track with respect to development of workforce, as qualitatively evaluated by external experts for Nanoscale Science and Engineering (NS&E) (Goal 12). External experts found that we continued to be on track.
- Continue to be on track with respect to maintaining a program that is responsible for a broad-based and capable interdisciplinary research community that advances fundamental nanotechnology knowledge, with impact on other disciplinary fields, as qualitatively evaluated by external experts for NS&E (Goal 14). External experts found this to be the case.
- Continue to be on track with respect to the successful development of a knowledge base for systematic control of matter at the nanoscale level that will enable the next industrial revolution for the benefit of society, as qualitatively evaluated by external experts for NS&E (Goal 15). External experts found this to be the case.
- Increase the average annualized new award size for research grants to $139,000 (Goal 16). We achieved $140,000 compared to $136,000 in FY 2003.
- Increase the average annualized research grant award size for Nanoscale Interdisciplinary Research within NS&E from $315,000 in FY 2003 to $330,000 in FY 2004 (Goal 17). We achieved $336,000 compared to $315,000 in FY 2003.
- Maintain the average annual award size for new Information Technology Research (ITR) research grants at $230,000 (Goal 18). We achieved $336,000 compared to $276,000 in FY 2003.

- Maintain the average award duration of new Information Technology Research (ITR) research grants at 3.3 years (Goal 20). In FY 2004 this award duration was 3.7 years equal to the result of 3.7 years in FY 2003.
- Maintain the average duration of new research grant awards for Nanoscale Interdisciplinary Research within the NS&E solicitation at 3.8 years (Goal 21). We achieved an average duration of 3.9 years in FY 2004 compared with 3.8 years in FY 2003.
- Increasing to 90% the percentage of facilities construction, acquisition and upgrade projects with negative cost and schedule variances of less than 10% of the approved project plan (Goal 23). In FY 2004, the percent of facilities achieving the goal was 100%.
- Increase the number of users accessing National Nanofabrication Users Network/National Nanotechnology Infrastructure Network (NNUN/NNIN) and Network for Computational Nanotechnology (NCN) sites to 4000 (Goal 25). In FY 2004 we had 6350 compared to 3000 in FY 2003.
- Increase the number of nodes that comprise infrastructure (Goal 26). In FY 2004 we had 20 nodes compared to 12 in FY 2003.
- Increase the peak available teraflops (trillions of floating point operations per second) for scientific computation (Goal 27). In FY 2004 we had 22 peak available teraflops compared to 12 in FY 2003.
- Obtain an external committee finding that research infrastructure is appropriate to enable major discoveries for NS&E (Goal 28). External experts found this to be the case.
- For 70% of proposals, to inform applicants whether their proposals have been declined or recommended for funding within six months of deadline or target date, or receipt date, whichever is later (Goal 30). In FY 2004 we achieved 77%, the same as in FY 2003.

We were not successful for 3 of our 26 other performance goals (12%). These were:

- Maintaining the percent of NS&E proposals with at least one minority principal investigator (PI) or co-principal investigator (Co-PI) at the FY 2003 performance level (Goal 8). We achieved 12% compared to 13% in FY 2003.
- Increasing the average duration of awards for research grants (Goal 19). In FY 2004 the average duration was 2.96 years compared to the goal of 3.0 years.
- Increasing the percent of operational facilities that keep scheduled operating time lost to less than 10% (Goal 24). In FY 2004, the percent of facilities that achieved the goal was 89.7% compared to the goal of 90%.

I. SUMMARY OF PERFORMANCE RESULTS

Overall, NSF was successful in achieving 90% (27 of 30) of the performance goals in FY 2004. Progress towards achievement of NSF's four strategic outcome goals is measured by NSF's performance with respect to annual performance goals for People (Goal 1), Ideas (Goal 13), Tools (Goal 22), and Organizational Excellence (Goal 29).

FY 2000 – FY 2004 Performance Results
Number of Goals Achieved

	FY 2000	FY 2001	FY 2002	FY 2003	**FY 2004**
Annual Performance Outcome Goals	6 out of 8 (75%)	4 out of 5 (80%)	4 out of 4 (100%)	4 out of 4 (100%)	**4 out of 4 (100%)**
Other Annual Performance Goals	12 out of 20 (60%)	11 out of 18 (61%)	14 out of 19 (74%)	10 out of 16 (63%)	**23 out of 26 (88%)**
Total	18 out of 28 (64%)	15 out of 23 (65%)	18 out of 23 (78%)	14 out of 20 (70%)	**27 out of 30 (90%)**

Note: In FY 2000 through FY 2003, Other Performance Goals include goals that have been identified as Investment Process goals or Management Goals.

The tables that follow provide a summary of NSF's FY 2004 results for GPRA and PART.

ANNUAL PERFORMANCE GOALS

Strategic Outcome	FY 2004 Annual Performance Goal	Results for National Science Foundation
People Strategic Outcome Goal **Outcome Goal:** A diverse, competitive, and globally engaged U.S. workforce of scientists, engineers, technologists and well-prepared citizens.	***Performance Goal 1:*** **NSF will demonstrate significant achievement for the majority of the following performance indicators related to the People outcome goal:**	**FY 2001:** NSF successful for related goal. **FY 2002**: NSF successful for related goal. **FY 2003**: NSF successful for related goal. **FY 2004: NSF is successful for goal 1.**
	Indicators:	**Indicator Results:**
	Promote greater diversity in the science and engineering workforce through increased participation of underrepresented groups and institutions in all NSF programs and activities.	Demonstrated significant achievement
	Support programs that attract and prepare U.S. students to be highly qualified members of the global S&E workforce, including providing opportunities for international study, collaborations and partnerships.	Demonstrated significant achievement.
	Develop the Nation's capability to provide K-12 and higher education faculty with opportunities for continuous learning and career development in science, technology, engineering and mathematics.	Demonstrated significant achievement.
	Promote public understanding and appreciation of science, technology, engineering, and mathematics, and build bridges between formal and informal science education.	Demonstrated significant achievement.
	Support innovative research on learning, teaching and mentoring that provides a scientific basis for improving science, technology, engineering and mathematics education at all levels.	Demonstrated significant achievement.
	FY 2004 Result: External expert assessment found that NSF has demonstrated significant achievement for each of the performance indicators associated with this goal.	

ANNUAL PERFORMANCE GOALS (continued)

Performance Area	FY 2004 Annual Performance Goal	Results for National Science Foundation
Fellowships	***Performance Goal 2:*** Number of U.S. students receiving fellowships through Graduate Research Fellowships (GRF) and Integrative Graduate Education and Research Traineeships (IGERT). FY 2002 Result 3011 FY 2003 Result 3328 FY 2004 Goal Increase FY 2004 Result 3681 FY 2004 Result: NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 2.**
Fellowships	***Performance Goal 3:*** Stipend level for Graduate Research Fellowships (GRF) and Integrative Graduate Education and Research Traineeships (IGERT) awards (dollars/year). FY 2000 Goal $15,000 FY 2000 Result $16,800 FY 2001 Goal $16,000 FY 2001 Result $18,000 FY 2002 Goal $18,000 FY 2002 Result $21,500 FY 2003 Goal $27,500 FY 2003 Result $27,500 FY 2004 Goal $30,000 FY 2004 Result $30,000 FY 2004 Result: NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 3.**
Fellowships	***Performance Goal 4:*** Number of applicants for Graduate Research Fellowships from groups that are underrepresented in the science and engineering workforce. FY 2002 Result 730 FY 2003 Result 820 FY 2004 Goal Increase FY 2004 Result 1009 FY 2004 Result: NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 4.**

ANNUAL PERFORMANCE GOALS (continued)

Performance Area	FY 2004 Annual Performance Goal	Results for National Science Foundation
Diversity	***Performance Goal 5:*** Number of applications for Faculty Early Career Development Program (CAREER) awards from investigators at minority-serving institutions. FY 2002 Result 60 FY 2003 Result 67 FY 2004 Goal Increase FY 2004 Result 82 FY 2004 Result: NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 5.**
Diversity	***Performance Goal 6:*** Percent of Nanoscale Science and Engineering (NS&E) proposals with at least one female principal investigator (PI) or Co-PI. FY 2001 Result 25% FY 2002 Result 25% FY 2003 Result 22% FY 2004 Goal 25% FY 2004 Result 26% FY 2004 Result: NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 6.**
Diversity	***Performance Goal 7:*** Percent of Information Technology Research (ITR) proposals with at least one female principal Investigator (PI) or Co-PI. FY 2001 Result 24% FY 2002 Result 25% FY 2003 Goal 24% FY 2003 Result 26% FY 2004 Goal 25% FY 2004 Result 29% FY 2004 Result: NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 7.**

ANNUAL PERFORMANCE GOALS
(continued)

Performance Area	FY 2004 Annual Performance Goal	Results for National Science Foundation
Diversity	***Performance Goal 8:*** Percent of Nanoscale Science and Engineering (NS&E) proposals with at least one minority principal investigator (PI) or Co-PI. FY 2001 Result 10% FY 2002 Result 10% FY 2003 Result 13% FY 2004 Goal 13% FY 2004 Result 12% FY 2004 Result: NSF is not successful for this goal. We will continue our efforts to encourage minorities to submit proposals to these areas.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is not successful for goal 8.**
Diversity	***Performance Goal 9:*** Percent of Information Technology Research (ITR) proposals with at least one minority principal investigator (PI) or Co-PI. FY 2001 Result 7% FY 2002 Result 7% FY 2003 Goal 7% FY 2003 Result 7% FY 2004 Goal 7% FY 2004 Result 9% FY 2004 Result: NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 9.**
Multidisciplinary	***Performance Goal 10:*** Percent of Nanoscale Science and Engineering (NS&E) proposals that are multi-investigator proposals. FY 2001 Result 75% FY 2002 Result 75% FY 2003 Goal 75% FY 2003 Result 73% FY 2004 Goal 75% FY 2004 Result 80% FY 2004 Result: NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 10.**

ANNUAL PERFORMANCE GOALS (continued)

Performance Area	FY 2004 Annual Performance Goal	Results for National Science Foundation
Multidisciplinary	***Performance Goal 11:*** Percent of ITR proposals that are multi-investigator FY 2001 Result 59% FY 2002 Result 58% FY 2003 Goal 50% FY 2003 Result 59% FY 2004 Goal 50% FY 2004 Result 62% FY 2004 Result: NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 11.**
Workforce	***Performance Goal 12:*** Successful development of workforce, as qualitatively evaluated by external experts for NS&E. FY 2004 Goal On-track FY 2004 Result On-track FY 2004 Result: Based on the NanoScience and Engineering Committee of Visitors (COV) report NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 12.**

ANNUAL PERFORMANCE GOALS (continued)

Strategic Outcome	FY 2004 Annual Performance Goal	Results for National Science Foundation
Ideas Strategic Outcome Goal **Outcome Goal:** Discovery across the frontier of science and engineering, connected to learning, innovation and service to society.	***<u>Performance Goal 13:</u>*** **NSF will demonstrate significant achievement for the majority of the following performance indicators related to the Ideas outcome goal:** **Indicators:**	**FY 2001:** NSF successful for related goal. **FY 2002**: NSF successful for related goal. **FY 2003**: NSF successful for related goal. **FY 2004: NSF is successful for goal 13.** **Indicator Results:**
	Enable people who work at the forefront of discovery to make important and significant contributions to science and engineering knowledge.	Demonstrated significant achievement.
	Encourage collaborative research and education efforts – across organizations, disciplines, sectors and international boundaries.	Demonstrated significant achievement.
	Foster connections between discoveries and their use in the service of society.	Demonstrated significant achievement.
	Increase opportunities for underrepresented individuals and institutions to conduct high quality, competitive research and education activities.	Demonstrated significant achievement.
	Provide leadership in identifying and developing new research and education opportunities within and across S&E fields.	Demonstrated significant achievement.
	Accelerate progress in selected S&E areas of high priority by creating new integrative and cross-disciplinary knowledge and tools, and by providing people with new skills and perspectives.	Demonstrated significant achievement.
	<u>FY 2004 Result:</u> External expert assessment found that NSF has demonstrated significant achievement for each of the performance indicators associated with this goal.	

ANNUAL PERFORMANCE GOALS
(continued)

Performance Area	FY 2004 Annual Performance Goal	Results for National Science Foundation
Ideas: Interdisciplinary Nanotechnology	***Performance Goal 14:*** Qualitative assessment by external experts that program is responsible for a broad-based and capable interdisciplinary research community that advances fundamental nanotechnology knowledge, with impact on other disciplinary fields. FY 2004 Goal — On-track FY 2004 Result — On-track FY 2004 Result: Based on the NanoScience and Engineering (NS&E) Committee of Visitors (COV) report NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 14.**
Ideas: Knowledge Base Nanotechnology	***Performance Goal 15:*** As qualitatively evaluated by external experts, the successful development of a knowledge base for systematic control of matter at the nanoscale level that will enable the next industrial revolution for the benefit of society. FY 2004 Goal — On-track FY 2004 Result — On-track FY 2004 Result: Based on the NanoScience and Engineering (NS&E) Committee of Visitors (COV) report NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 15.**
Award Size	***Performance Goal 16:*** NSF will increase the average annualized award size for research grants to $139,000. FY 2000 Result — $106,000 FY 2001 Goal — $110,000 FY 2001 Result — $114,000 FY 2002 Goal — $113,000 FY 2002 Result — $116,000 FY 2003 Goal — $125,000 FY 2003 Result — $136,000 FY 2004 Goal — $139,000 FY 2004 Result — $140,000 FY 2004 Result: NSF is successful for this goal.	**FY 2001:** NSF successful **FY 2002:** NSF successful **FY 2003:** NSF successful **FY 2004: NSF is successful for goal 16.**

ANNUAL PERFORMANCE GOALS
(continued)

Performance Area	FY 2004 Annual Performance Goal	Results for National Science Foundation
Award Size	***Performance Goal 17:*** Average annualized new research grant award size for Nanoscale Interdisciplinary Research within the Nanoscale Science and Engineering (NS&E) solicitation. FY 2001 Result $363,000 FY 2002 Result $323,000 FY 2003 Goal $330,000 FY 2003 Result $315,000 FY 2004 Goal $330,000 FY 2004 Result $336,000 FY 2004 Result: NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 17.**
Award Size	***Performance Goal 18:*** Average annual award size for new ITR research grants. FY 2001 Result $242,000 FY 2002 Result $226,000 FY 2003 Goal $230,000 FY 2003 Result $276,000 FY 2004 Goal $230,000 FY 2004 Result $336,000 FY 2004 Result: NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 18.**

ANNUAL PERFORMANCE GOALS (continued)

Performance Area	FY 2004 Annual Performance Goal	Results for National Science Foundation
Award Duration	***Performance Goal 19:*** The average duration of awards for research grants will be 3.0 years. FY 2000 Result 2.8 years FY 2001 Goal 3.0 years FY 2001 Result 2.9 years FY 2002 Goal 3.0 years FY 2002 Result 2.9 years FY 2003 Goal 3.0 years FY 2003 Result 2.9 years FY 2004 Goal 3.0 years FY 2004 Result 2.96 years FY 2004 Result: NSF is not successful for this goal: Progress on this goal is budget dependent. Program Directors must balance competing requirements: increasing award size, increasing duration of awards, and/or making more awards. NSF will continue to focus on increasing award size and duration, together with recovering from recent declines in success rates, as permitting within budget constraints.	**FY 2000:** Goal not included in Performance Plan **FY 2001:** NSF not successful **FY 2002:** NSF not successful **FY 2003:** NSF not successful **FY 2004: NSF is not successful for goal 19.**
Award Duration	***Performance Goal 20:*** Average award duration of new ITR research grants (in years). FY 2001 Result 3.4 FY 2002 Result 3.3 FY 2003 Goal 3.3 FY 2003 Result 3.7 FY 2004 Goal 3.3 FY 2004 Result 3.7 FY 2004 Result: NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 20.**
Award Duration	***Performance Goal 21:*** Average duration (in years) of new research grant awards for Nanoscale Interdisciplinary Research within the Nanoscale Science and Engineering solicitation. FY 2001 Result 4 FY 2002 Result 3.7 FY 2003 Goal 3.8 FY 2003 Result 3.8 FY 2004 Goal 3.8 FY 2004 Result 3.9 FY 2004 Result: NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 21.**

ANNUAL PERFORMANCE GOALS
(continued)

Strategic Outcome	FY 2004 Annual Performance Goal	Results for National Science Foundation
Tools Strategic Outcome Goal **Outcome Goal:** Broadly accessible state-of-the-art S&E facilities, tools, and other infrastructure that enable discovery, learning and innovation.	***<u>Performance Goal 22:</u>*** **NSF will demonstrate significant achievement for the majority of the following performance indicators related to the Tools outcome goal:** **Indicators:**	**FY 2001:** NSF successful for related goal. **FY 2002**: NSF successful for related goal. **FY 2003**: NSF successful **FY 2004: NSF is successful for goal 22.** **Indicator Results:**
	Expand opportunities for U.S. researchers, educators, and students at all levels to access state-of-the-art S&E facilities, tools, databases, and other infrastructure.	Demonstrated significant achievement.
	Provide leadership in the development, construction, and operation of major, next-generation facilities and other large research and education platforms.	Demonstrated significant achievement.
	Develop and deploy an advanced cyberinfrastructure to enable all fields of science and engineering to fully utilize state-of-the-art computation.	Demonstrated significant achievement.
	Provide for the collection and analysis of the scientific and technical resources of the U.S. and other nations to inform policy formulation and resource allocation.	Demonstrated significant achievement.
	Support research that advances instrument technology and leads to the development of next-generation research and education tools.	Demonstrated significant achievement.
	<u>FY 2004 Result:</u> External expert assessment found that NSF has demonstrated significant achievement for each of the performance indicators associated with this goal.	

ANNUAL PERFORMANCE GOALS (continued)

Performance Area	FY 2004 Annual Performance Goal	Results for National Science Foundation
Construction and Upgrade of Facilities	**Performance Goal 23:** Percent of construction acquisition and upgrade projects with negative cost and schedule variances of less than 10% of the approved project plan. *FY 2004 target is 90%.* FY 2003 Goal 90% FY 2003 Result: 88% FY 2004 Goal 90% FY 2004 Result: Data collected from Facilities Managers external to NSF indicate that 100% (35 out of 35) of facilities kept any negative cost and schedule variances to less than 10 percent of the approved project plan. Later reporting of estimates to compare with actuals this past year may have contributed to the increase over the prior year.	FY 2003: NSF not successful **FY 2004: NSF is successful for goal 23.**
Operations and Management of Facilities	**Performance Goal 24:** Percent of operational facilities that keep scheduled operating time lost to less than 10%. *FY 2004 target is 90%.* FY 1999 Result: Reporting database 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 2001 Result: Of the 29 reporting facilities, 25 (86 percent) met the goal of keeping unscheduled downtime to below 10 percent of the total scheduled operating time. FY 2002 Result: Of the 31 reporting facilities, 26 (84 percent) met the goal of keeping unscheduled downtime to below 10 percent of the total scheduled operating time. FY 2003 Result: Of the 30 reporting facilities, 26 (87 percent) met the goal keeping scheduled operating time lost to less than 10 percent. FY 2004 Result: We were not successful in achieving this goal. Data collected from Facilities Managers external to NSF indicate that 89.7% (26 out of 29) facilities kept scheduled operating time lost to less than 10 percent. NSF will continue to work with Facility Managers to improve performance in this area.	**FY 1999:** Inconclusive for related goal **FY 2000:** NSF not successful for related goal **FY 2001:** NSF not successful **FY 2002:** NSF not successful **FY 2003:** NSF not successful **FY 2004: NSF not successful.**

ANNUAL PERFORMANCE GOALS (continued)

Performance Area	FY 2004 Annual Performance Goal	Results for National Science Foundation
Number of Users	***Performance Goal 25:*** Number of users accessing National Nanofabrication Users Network/National Nanotechnology Infrastructure Network (NNUN/NNIN) and Network for Computational Nanotechnology (NCN) sites. FY 2001 Result 1300 FY 2002 Result 1700 FY 2003 Goal 3000 FY 2003 Result 3000 FY 2004 Goal 4000 FY 2004 Result 6350 FY 2004 Result: NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004 NSF is successful for this goal.**
Number of Nodes	***Performance Goal 26:*** Number of nodes that comprise infrastructure. FY 2001 Result 5 FY 2002 Result 5 FY 2003 Goal 12 FY 2003 Result 12 FY 2004 Goal 14 FY 2004 Result 20 FY 2004 Result: NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 26.**
Scientific Computing	***Performance Goal 27:*** Peak available teraflops (trillions of floating point operations per second) for scientific computation FY 2002 Goal 6 FY 2002 Result 6 FY 2003 Goal 10 FY 2003 Result 12 FY 2004 Goal 20 FY 2004 Result 22 FY 2004 Result: NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 27.**
NS&E Infrastructure	***Performance Goal 28:*** External committee finding that research infrastructure is appropriate to enable major discoveries for Nanoscale Science and Engineering (NS&E). FY 2004 Goal On-track FY 2004 Result On-track FY 2004 Result: Based on the NanoScience and Engineering (NS&E) Committee of Visitors (COV) report NSF is successful for this goal.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 28.**

ANNUAL PERFORMANCE GOALS (continued)

Strategic Outcome	FY 2004 Annual Performance Goal	Results for National Science Foundation
Organizational Excellence Strategic Outcome Goal **Outcome Goal:** An agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices.	***Performance Goal 29:*** **NSF will demonstrate significant achievement for the majority of the following performance indicators related to the Organizational Excellence outcome goal:** **Indicators:** Operate a credible, efficient merit review system. Utilize and sustain broad access to new and emerging technologies for business application. Develop a diverse, capable, motivated staff that operates with efficiency and integrity. Develop and use performance assessment tools and measures to provide an environment of continuous improvement in NSF's intellectual investments as well as its management effectiveness. FY 2004 Result: Significant achievement was demonstrated for all indicators.	**(New Goal for GPRA Reporting)** **FY 2004: NSF is successful for goal 29.** **Indicator Results:** Demonstrated significant achievement. Demonstrated significant achievement. Demonstrated significant achievement. Demonstrated significant achievement.
Time to Decision	***Performance Goal 30:*** For 70 percent of proposals, be able to inform applicants whether their proposals have been declined or recommended for funding within six months of deadline or target date, or receipt date, whichever is later. FY 2000 Goal 70% FY 2000 Result 54% FY 2001 Goal 70% FY 2001 Result 62% FY 2002 Goal 70% FY 2002 Result 74% FY 2003 Goal 70% FY 2003 Result 77% FY 2004 Goal 70% FY 2004 Result 77%	**FY 2000:** NSF not successful **FY 2001:** NSF not successful **FY 2002:** NSF successful **FY 2002:** NSF successful **FY 2004: NSF is successful for goal 30.**

II. ACHIEVEMENTS NOTED BY THE ADVISORY COMMITTEE FOR GPRA PERFORMANCE ASSESSMENT

NSF is the only agency to invite an external advisory committee, the Advisory Committee for GPRA Performance Assessment (AC/GPA), to perform an analysis of its entire portfolio as part of the agency GPRA assessment process. The material in this section has been taken from the FY 2004 AC/GPA Report available at http://www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf04216. The referenced award numbers are links to the NSF web site and provide further information on the awards.

PEOPLE

Indicator P1. ***Promote greater diversity in the science and engineering workforce through increased participation of underrepresented groups and institutions in all NSF programs and activities.***

The nuggets described below illustrate the many groups and institutions that require attention under this indicator (African Americans, Latino Americans, American Indians, Alaska Natives, migrant workers, low-income Americans, the visually impaired, the deaf, etc.) as well as institutions that are focused on serving them (tribal colleges, HBCUs, Hispanic-serving institutions, etc.). The nuggets also illustrate a focus on innovative and effective inclusion of these various groups. Links to relevant awards are provided.

For example, the Agricultural Science Summer Undergraduate Research Education and Development Project (ASSURED) (0244179) introduces children of migrant worker families to research careers through summer projects in plant science relevant to the cultural background of those participants. This brings research close to home for the participants.

The Deaf Initiative in Information Technology (0070982) has sponsored 21 Information Technology (IT) workshops for deaf and hard of hearing professionals from across the country. While giving deaf and hard of hearing professionals the opportunity to enhance their IT skills, the program also provides faculty at the National Technical Institute for the Deaf professional development opportunities.

The Oglala Lakota Nation is benefiting from a program to create a pool of scientists and lab technicians with entrepreneurial skills (0123149). Full time enrollment by American Indians in Oglala Lakota College on South Dakota's Pine Ridge Reservation has increased steadily and matriculation of students into four-year degree programs in partner higher education institutions has doubled in the last three years. This project takes place in an EPSCoR state at a tribal institution.

With support from NSF and several other Federal agencies, the National Society of Black Physicists (NSBP), in response to student demand, offered an intensive summer course in 2003 in the theoretical and mathematical frameworks necessary to work in the areas of physics encompassing gravity, astrophysics, and M-theory – a variant of string theory (0243399). Paul Gueye, Hampton University, and James Gates, University of Maryland, organized the course. About half of the attendees were African-American and members of the NSBP. Many of these students are now actively considering careers in physics.

Another summer program, Enhancing Diversity in Graduate Education (EDGE) held in 2003 at Pomona College, immersed bright women students, about half from minority groups, in training and mentoring in mathematics (0209478). The career-stimulating success rate is high: all the women who participated have been accepted to graduate school and two have completed a first year. The EDGE program is unique in that it represents perhaps the last time in the mathematical careers of the participants during which they are surrounded by other women.

<u>Indicator P2.</u> Support programs that attract and prepare U.S. students to be highly qualified members of the global science and engineering (S&E) workforce, including providing opportunities for international study, collaborations and partnerships.

Four investigator-driven research projects are illustrated that have clearly had an impact on student activities internationally. The first started with a planning visit and was followed by a workshop organized by Kate Miller at the University of Texas at El Paso (0118594, 0325020). This international research collaboration has opened up research opportunities for geologists in a new part of the world, permitting U.S. graduate students to participate in research in the Kingdom of Bhutan in the Himalayan-Tibetan mountain range. This seismically active part of the world has only recently been opened up to Western investigators. Dr. Miller and her graduate students have been able to work side-by-side with Bhutanese scientists to obtain the first detailed seismic and geodetic measurements in this portion of the Himalayan-Tibetan mountain range. This is an extraordinary opportunity for students to work in an isolated and exotic part of the world in collaboration with indigenous people who share similar scientific interests but very different cultural and language backgrounds.

Moving from the Himalayas to East Africa, the second investigator-driven project is an REU (Research Experiences for Undergraduate) site led by Andrew Cohen of the University of Arizona (0223920). Interested in the effects of climate change on fish populations in Lake Tanganyika, Dr. Cohen has been able to take groups of undergraduate students to East Africa to help study and sample the fish and investigate how climate has affected fish populations on the African continent. As part of their experiences, the U.S. students work and live side-by-side with African scientists and students. In addition to gaining valuable research experience, these students also gain an awareness and experience with cultures and languages very different from their own.

The third example is a U.S.-Russian collaboration to develop a microbial observatory (0238407). The unique geothermal conditions present in some parts of the world, particularly in deep ocean vents, have led to extraordinary discoveries of living microbes in what had been thought to be conditions totally unsuitable for life. This collaboration, led by Juergen Wiegel at the University of Georgia, will allow teams of U.S. researchers and graduate students opportunities to work with Russian scientists to begin a systematic study of the Kamchatka region in Siberia. As a bonus, it is expected that microorganisms with a high potential for industrial application may be discovered during this work.

Finally, under the auspices of NSF's International Research Fellowship Program, postdoctoral researcher Geoffrey Braswell participated in an archaeological dig in the ancient Mayan city of Pusilha in Belize in Central America (0202581). In collaboration with the Archaeological Coordinator of the Ministry of Tourism in Belize, Dr. Braswell was able to recover many ancient artifacts and ceramics dating back to A.D. 500-950. He worked closely with local scientists to help excavate this archaeologically significant site that will eventually be economically significant to Belize from both the historical and tourism viewpoints.

To further illustrate the profound and significant impact that NSF awards may have on promoting global awareness and scientific research, an additional nugget is used to illustrate a much larger and broader scope project than those described above. This example is the "East Asia Summer Institutes for American Graduate Students in Science and Engineering," which provided an opportunity for 73 graduate students to live and work in Japan or Korea for eight weeks during the summer of 2003 (0310315). Being immersed in the culture, language, and scientific expertise of these countries is invaluable in terms of providing an international perspective and understanding to young people who are training to be scientists and engineers.

The range and array of international activities that are facilitated through the NSF are truly impressive. There is no part of the world that is not touched by the global nature of research efforts undertaken by NSF-sponsored U.S. students and researchers. The value of these efforts to our nation and the world is enormous, especially at a time when we may be losing ground in terms of bringing international students and scholars into the United States.

***Indicator P3.* Develop the Nation's capability to provide K-12 and higher education faculty with opportunities for continuous learning and career development in science, technology, engineering and mathematics.**

The Columbus Ohio Urban Systemic Program (CUSP) demonstrates the impact of a large-scale change activity on district-wide student performance (0115599). CUSP offered professional development to more than 2,400 K-12 teachers to enable standards-based, inquiry-centered instruction to become classroom reality. Increased teacher effectiveness is the reason given for increasing the pass rate from three percent to 83 percent in elementary science in one school. Teachers have increased levels of comfort in implementing inquiry-based instruction and principals report that teachers' receptivity to inquiry-based learning has dramatically increased. On the Ohio Proficiency Test, the district outperformed the state average in mathematics and science at every tested grade level.

An innovative method of teaching known as Process Oriented Guided Inquiry Learning (POGIL) is an example of college-level adoption of an innovative method of teaching (0231120). This technique replaces the traditional lecture format with a learner-centered approach in which students explore data, search for patterns, develop concepts to explain these patterns, and then apply these concepts to new situations. The technique has been applied to general chemistry, organic chemistry and physical chemistry that, traditionally, have had high rates of attrition. The effectiveness of this approach has been demonstrated at the University of New Mexico, SUNY Stony Brook, Franklin and Marshall College, Carleton College, Washington College, and Catholic University. Through national dissemination, it is hoped that a critical mass of practitioners will change the culture in chemistry and increase the awareness and appreciation of learner-centered pedagogies.

In cooperation with the American Association of Community Colleges (AACC), Microsoft, and the NSF-funded National Workforce Center for Emerging Technologies (NWCET), more than 800 IT faculty from 300 different colleges upgraded their skills in the summer of 2003 by attending one of ten regional Working Connections IT Faculty Development Institutes (9553727, 9813446, 0101657). The goal of the institutes is to build a world-class national infrastructure to upgrade faculty skills to ensure that community and technical colleges are preparing globally competitive IT workers.

The National Computational Science Institute (NCSI) offered workshops for faculty from predominantly undergraduate institutions, minority serving institutions, and community colleges using in-person, video-conferenced, and web-accessible workshops, seminars and support activities to introduce hands-on computational science, numerical models and data visualization tools (0127488). NCSI also co-led the Supercomputing Conference 2003 Education Program that supported teams of K-12 teachers and undergraduate faculty as they learned about computational science tools and methods for invigorating their math and science courses. More than 100 participants were engaged in four days of intensive hands-on workshops to learn about modeling and visualization tools and methods including systems dynamics modeling, algebraic modeling, numerical modeling, agent systems modeling, and visualization techniques. Following the workshop, participants were encouraged and supported to attend regional summer workshops offered by NCSI at more than 15 workshops hosted at different colleges and universities, many of which are minority serving institutions.

A workshop (TeacherTech03) for Pittsburgh Public Schools middle and high school science teachers to enable them to effectively incorporate technology tools into their science curriculum and to raise awareness of the teacher's role in shaping and encouraging students to be scientists was sponsored by the Pittsburgh Supercomputing Center, the Pittsburgh Public Schools, the NSF's Education, Outreach and Training Partnership for Advanced Computational Infrastructure (EOT-PACI) and the Rice University Center for Equity and Excellence in Education (0328525). Throughout the week, participants studied and tested the technology that they could use in their own curriculum. They learned to download data automatically from the calculator to an Excel spreadsheet to create lab reports; they used web-based simulation tools to analyze a segment of a food chain to study population growth; and they engaged in discussions about the teacher's role in shaping the next generation of scientists. Post-workshop evaluations were very positive, but data are not available to indicate the impact the program would have in the classroom.

***Indicator P4.* Promote public understanding and appreciation of science, technology, engineering, and mathematics, and build bridges between formal and informal science education.**

Three themes emerged from the nuggets in this category: high public interest/information transfer, general public doing science, and education.

High Public Interest – Information Transfer

There are some areas of science, such as astronomy, exploration, and health, which attract public interest more than some other areas. The impact of these projects generally is based on the transfer of information to the general public, rather than the active involvement of citizens or students in the scientific process. Other nuggets, not discussed here in detail, describe products as varied as planetarium shows, IMAX movies, PBS television series, children's books, and websites.

A somewhat unexpected example of this kind of work is provided by NSF CAREER award winner Duncan J. Watts, who has written a popular level book on his research (Six Degrees: the Science of a Connected Age) (0094162). It has attracted more than the usual amount of interest on Amazon.Com, and has 17 favorable reviews to its credit. Particularly noteworthy is one review, where reviewer James Chu noted that Watts "questioned the possible flaws and mistakes in his own theories and opinions, granting the readers some space to think, and to better digest the contents of this book." (James Chu, Amazon review dated 2/14/04). The usual tendency in books like this is for authors to give highly uncritical accounts of their own work and present it as though it were established beyond any possible question. Watts is more humble, and thus makes readers think. He gives readers a taste of the side of science where tentative explanations can sometimes be wrong. This book was correctly identified as a high-risk project.

The Methuselah of NSF-funded public outreach programs is the radio program "Earth and Sky," heard by three million listeners in the United States and in continuous operation since the early 1980s (counting Block and Byrd's time with the similar "StarDate" radio series for the University of Texas at Austin) (9253378, 0125087, 0128985). This program has now considerably expanded its focus from its original basis, involving nearly 400 scientists as advisers in its production. The quality of these programs remains at a very high level, even though the principal author of these scripts has been doing this for almost 25 years.

General Public Doing Science

Somewhat more unusual are projects where the general public is asked to do something more than just read about science, or watch videos. An interesting example of such a project is the development of a birding database in the award "Citizen Science Online" (0087760). Interested people with no specialized training learn to identify species, follow observing protocols, and submit counts that are good enough that ornithologists will use the data. This grant represents a significant step forward from some other efforts, which were mostly done at the state level. A Committee member encountered people using these databases on a recent college class field trip. Bird experts and university colleagues verified the high quality of the data, and direct observation of enthusiastic birders on a cold day in May indicated the level of interest in this kind of activity.

Somewhat similar in spirit, but directly involving K-12 students, is the ALISON Project (Alaska Lake Ice and Snow Observatory Network) (0326631). In this activity, K-12 students in a network of schools become reliable observers of such quantities as snow depth. The students are trained to interpret as well as gather data. A website http://www.gi.alaska.edu/alison/ even has a flow chart showing how the observations gathered by students are used to determine the thermal conductivity of the snow pack. The website also contains a comparison of measurements made at different observatories throughout Alaska; such a comparison could easily be done by the teachers and students themselves.

Education

NSF has funded a fairly extensive number of curriculum or program development projects whose aim is to reach out to underrepresented groups. A target audience is identified in a particular geographical area. The interests of the PIs lead to the development of a curricular unit or after-school program that relates to some discipline. In some cases the discipline is one whose community believes, often with some justification, that it is underrepresented in the school curriculum. The teaching techniques used in these projects communicate a very different vision of science than is sometimes done in middle and high school where teacher-talk (lecturing) is the predominant mode of teaching.

An example is the California State University–San Bernardino award entitled "Earth Science Pipeline: Recruiting and Retaining Underrepresented Ethnic Groups in Earth Sciences" (0119934). Through an extensive outreach program to nearly 5,000 middle and high school students in the CSUSB service area, the program brings the students to the campus for hands-on activities and field trips. The majority of the students are from ethnic groups that are underrepresented in the geosciences. An important part of the program is a biannual Global Positioning System (GPS) campaign, which allows the students to work with scientists to use state of the art GPS receivers in tectonic research. In addition to the middle and high school students, undergraduates and graduate students from nearby community colleges and other CSU institutions are involved in the summer research projects.

As NSF support increases for projects like these, more and more products will become available that will make it easier for others to replicate. With the recent NSF emphasis on including more science education research in EHR grants, information will be available so that people starting, after-school programs may determine under what circumstances particular programs were effective.

Indicator P5. ***Support innovative research on learning, teaching and mentoring that provides a scientific basis for improving science, technology, engineering and mathematics education on all levels.***

The Math and Science Partnership (MSP) program includes two broad components: the partnership between higher education institutions and K-12 school districts, and the Research, Evaluation, and Technical Assistance program (MSP-RETA). In the latter, three awards in particular are excellent examples of collaborative, multi-partner, multi-focus projects: "Design, Validation, and Dissemination of Measures of Content Knowledge for Teaching Mathematics," "Mathematical ACTS," and "Longitudinal Design to Measure Effects of MSP Professional Development in Improving Quality of Instruction in Mathematics and Science Education" (0335411, 0226948, 0233505). In the first award, the University of Michigan developed instruments to assess teachers' knowledge of mathematics content and how this content is used in teaching mathematics. Similar instruments were used in the second award, and the results from the two awards were compared and contrasted. In the third award, a collaborative research team from the Wisconsin Center for Education Research and the American Institutes for Research investigated how professional development programs and activities in multiple sites may be evaluated using a common set of research-based measures. The tools developed in this program assist the partnerships in assessing alignment or misalignment of project strategies with school needs. While these projects impact grades 4-8, the potential impact [is] broad and could impact any level in K-12.

An interesting project, "Science Analysis for TIMSS-R Videotape Classroom Study," (0002778) focused on the teaching of mathematics in eighth grade. This study compared the teaching of mathematics in the United States, Australia, the Czech Republic, Hong Kong, Japan, the Netherlands, and Switzerland, the countries with top-performing students on the TIMSS 1995 mathematics assessment. The study revealed similarities and differences in the way mathematics is taught in these countries. The data from this study will provide a valuable source of information for secondary analysis. The project made considerable contributions to the methodology of classroom video studies. The databases of teaching practice developed in this project will support both research and education of pre- and in-service teachers.

To demonstrate how effective research can lead to an exemplary education program, Cornell University involved faculty from nine departments, as well as undergraduate and graduate students, in research focused on a combination of theoretical and empirical approaches to the understanding of evolution in an award, "Evolution from DNA to the organism: The Interface Between Evolutionary Biology and the Mathematical Sciences" (9602229). Students gained deep understanding of evolutionary biology and applied mathematics that permitted them to work at the forefront of modern quantitative biology. This project involved a considerable number of underrepresented and international students. The experience gained in this project prompted the PI to found the Mathematical and Theoretical Biology Institute (MTBI), a summer program at the Los Alamos National Laboratory to encourage involvement of minority students in this highly interdisciplinary field.

The ARCHway Project at the University of Kentucky is a multidisciplinary program that involves a high level of interaction in teaching and research (0219924). Professors, graduate students, and undergraduate students in English and computer science are working together as a team to develop a workbench for creating and deploying image-based electronic editions of unique, historic manuscripts. Two very different disciplines bring different and indispensable knowledge and skills to this project. Students participating in this project learn more about their own discipline and gain better understanding and appreciation for the other discipline as well.

The Research on Learning and Education (ROLE) Program is one of the first studies on how teaching occurs in a surgical operating room (0126104). This is a multidisciplinary study that brings together psychologists skilled in cognitive research, communications scientists expert in the study of discourse, and experienced surgeons. While the project appears narrow in scope, it has broad implications for instruction in similarly complex situations such as classrooms or emergency response training.

The five nuggets selected illustrate NSF's effectiveness in pursuing the agenda of improving education at all levels, merging education and research in different ways and to a varied extent. Among so many excellent projects it was difficult to select the most representative and impressive ones.

IDEAS

***Indicator I1.* Enable people who work at the forefront of discovery to make important and significant contributions to science and engineering knowledge.**

Notable among these awards were several that led to two Nobel Prizes in 2003. A series of awards made in the 1980s and 1990s to Robert Engle and Clive Granger by the Economics Program allowed these economists to develop new statistical methods for treating chronological sequences of observations to estimate relationships and test hypotheses based on economic theory (8008580, (8004414, and 9730062). These methods have been invaluable for economic research, government policy, and investment decisions. The number of NSF-supported economists who have won the prestigious Nobel Prize has now increased to seventeen. The success of these individuals is ample demonstration of the continuing quality of NSF funded work in this area.

The 2003 Nobel Prize for Physiology and Medicine was awarded to Paul Lauterbur for development of both the theoretical idea and the physical implementation of Magnetic Resonance Microscopy Imaging (8008629). MRI involves an ideal noninvasive method for medical diagnostics involving no ionizing radiation. Now at the University of Illinois, Dr. Lauterbur was funded by the Engineering Directorate's Civil and Mechanical Systems Division in the early 1980s to refine MRI into the routine diagnostic technique that it is today.

For a ten-year period in the 1990s the Biological Sciences directorate (BIO) led the world in organizing and implementing the sequencing of entire genome of a higher plant, *Arabidopsis thaliana.* The sequencing of the genome was an NSF-led international effort, involving the United States, the European Community, and Japan. *Arabidopsis* and rice are the only higher plants for which the entire sequence is known. *Arabidopsis* was completed in 2000 and rice in 2002. Researchers around the world are now able to make rapid advances in understanding the life of plants in a fundamentally new way. A 2002 award from the *Arabidopsis* 2010 initiative of the BIO Directorate to Philip Benfey of Duke University allowed him to be able to elucidate every gene that was active in every cell of the *Arabidopsis* root during its development and to begin to understand the networks of genes which control cell and organ development in the root (0209754). Given that all roots follow the same general developmental program this work should be applicable to improving understanding of development of agriculturally important crop plants such as maize and rice.

In the world in which we live, the ability to remotely sense chemical, or by extension, biological warfare agents is of paramount importance. The work of Sylvia Daunert of the University of Kentucky, supported by the Chemistry Division, has demonstrated that genetically engineered bacteria that produce light in the presence of Chemical Warfare Agents (CWA) could be introduced and would multiply in the gut of an insect (butterfly) through the award "Optical Sensing Based on Inducible Bacterial Luminescence" (9820808). The butterflies could then be used either to survey a field or for continuous monitoring and can be remotely monitored up to 19Km away. This system could be developed for monitoring a large number of chemical or biological agents and be monitored without endangering human observers.

Understanding environmental changes that have the potential to impact the entire earth and man's ability to live on it is crucially important in informing a global environmental policy. The research of John Toole and Ruth Curry at the Woods Hole Oceanographic Institution supported by the Geosciences (GEO) Directorate (0241354 and 0326778) has unequivocally demonstrated that since 1990, ten of the warmest years on record have occurred, and that the tropical oceans have become more salty as a result of evaporation and the polar oceans have more fresh water as a resulting of icecap melting. These events have the potential to affect global precipitation patterns that govern the distribution and severity of droughts, floods, and storms.

As the world becomes more connected and more data is being transmitted throughout the "cybersphere," improvements in the ability to transmit, organize, and store this data are essential to the continued growth and development of cyberinfrastructure. Two awards, one made by the Engineering Directorate and the second by the Directorate for Mathematical and Physical Sciences, have greatly facilitated the transmission of information. Robert Buhrman from the Center for Nanoscale Systems and Information Technologies at Cornell University has characterized a low-loss photonic band-gap fiber (PBGF) that looses light intensity 200 times slower than current cable (0117770). Other awards have facilitated the development of "grid computing," a new style of computing that enable researchers to find the data they need, to process that data, and to extract discoveries from that data across multiple sites in ways that have not been available until now: "ITR/AP: An International Virtual-Data Grid Laboratory for Data Intensive Science" (0122557), "The ATLAS Research Program: Empowering U.S. Universities (0204877), and " Empowering Universities: Preparation for the CMS Research Program" (0204786).

The Engineering Directorate has supported inventive and creative projects in the development of advanced materials, from bridge construction to the replacement of human tissues. In bridge construction, Nabil Grace and his research team comprised primarily of undergraduates at Lawrence Technological University developed a non-corrosive carbon based reinforcement to replace steel in the construction and reinforcement of prestressed concrete structures (9906404, 9900809). A bridge built using this composite was completed in 2003 and won that year's Construction and Design Award from the Construction Industry Council. In human tissue replacement, a major challenge in developing engineered substitutes for human tissue has been the ability to monitor the replacement structures directly and non-invasively in vivo after implantation. Researchers at the Georgia Tech/Emory University ERC (Engineering Research Center) for the Engineering of Living Tissues have devised a way of using Nuclear Magnetic Resonance (NMR) imaging to monitor and evaluate non-invasively the functioning and effectiveness of new tissue constructs in the human body (9731643).

***Indicator I2.* Encourage collaborative research and education efforts – across organizations, disciplines, sectors and international boundaries.**

Several excellent examples of collaborative projects that have contributed to the development of new ideas within disciplines and across disciplines are found in NSF's portfolio. For example, Timothy Koschmann's study of medical education, "Toward a Descriptive Science of Learning Practices," brought together psychologists, communications scientists, and physicians to develop a new methodological approach to the documentation of instructional practices (0126104). This is one of the first fine-grained studies of how teaching occurs in a surgical operating room. Stefan Schaal and Christopher Atkeson's "ITR: Collaborative Research: Using Humanoids to Understand Humans" (0326095 and 0325383) focuses on educating robots rather than doctors, but involved a similarly multidisciplinary team of scholars – a robot engineer, a modeler of human learning, and a software specialist. This cross-disciplinary team has demonstrated how the skills of robots can be expanded dramatically and quickly by programming them with two brain-like qualities: (1) a better ability to learn skills by initially copying humans; and (2) an ability to improve these skills further through practice, using a kind of learning called advanced reinforcement learning or adaptive dynamic programming (ADP).

An interesting example of collaboration across international boundaries is one in which a research team led by an anthropologist and a psychologist included research assistants from Guatemala, Mexico, Chile, France, and the United States (9981762 and 9910156). The project also involves collaboration across institutions. Researcher Medin is at the College of the Menominee Nation and Atran is at the University of Michigan in Ann Arbor. Atrin and Medin explore how cultural differences influence actions taken with respect to the environment and develop both new theoretical insights as well as new directions for public policy. Rollin-Smith's (0131184) study on antimicrobial peptide defenses in amphibian skin illustrates a different form of international collaboration. The principal researcher's study of frogs that lack protection from fungal infection is being done in concert with studies by other researchers from Australia, Europe, and Central America. This project contributes to the training of young scientists at all levels (high school, undergraduate, graduate, and postdoctoral fellows), as well as minorities. These young scientists are trained in all aspects of science from the molecular to whole-organism level. Rollins-Smith and her laboratory is the leader in identifying antimicrobial peptides in frog skin, the protein sequences of which could lead to development of therapeutic agents in the future.

NSF funding has also supported collaborative efforts across sectors and organizations. A Nanoscale Interdisciplinary Research Team (NIRT) project at Washington University brings together scientists from industry (IBM) and a national laboratory (NIST) to develop synthetic strategies and characterization protocols for the production and study of one-, two-, and three-dimensional superstructures composed of stabilized nanoparticle assemblies (0210247). This project has led to a totally surprising and unexpected result, which opens new horizons in research on polymeric fluids. The leading scientific magazine *Nature* published a commentary under its "Views" section titled "Nanoparticles Stump Einstein." (Nature "Views")

Indicator I3. ***Foster connections between discoveries and their use in the service of society.***

Steven Levitt of the University of Chicago received the prestigious John Bates Clark Medal from the American Economics Association in 2003 for research in the economics of gangs (9876098). He researched a variety of social problems and crime prevention involving a broad range of disciplines like economics, politics, sociology, and law (e.g., understanding gang dynamics, manipulation of standardized testing, ways to reduce car theft, etc).

Another example is a study examining how curriculum and available courses shape high school students' progress through science and mathematics and into science and teaching professions. Chandra Muller of the University of Texas conducted research on "Science Achievement and Health Behavior: High School Curriculum, Social Context, and Opportunity to Learn" (0126167). This study has produced a unique and rich data set that shows that minority students and those from families with lower socioeconomic status tend to have less access to advanced coursework from the start of their high school years and that this gap continues to grow throughout their high school years. This study also examined remedies. For example, female students who participate in science classes that are more active in nature, in terms of allowing students to design projects and work together in groups, are more likely to pursue advanced coursework in biology.

NSF has also funded proposals whose ideas have made it into the marketplace. For example, a video compression-decompression algorithm produced by Avideh Zakhor at the University of California-Berkeley (9903368) is now in use on video streaming application in the major U.S. telecommunication companies. This is a compelling example of how very theoretical research conducted in an academic institution can make the transition into the marketplace and have significant economic impact.

One last example (the first white-light polymeric) is a grant that led to the production of the first white-light polymeric light-emitting diodes (LED) (0209651). One can see these LEDs today in telephone handsets, street signs, and flat-panel displays. However, until this grant they could only be produced in a single color (e.g. red, yellow, green, blue). As a result of NSF's investments, LEDs now emit brighter and much cooler light than the standard incandescent lamps and have a far longer lifetime and produce variable colors depending on the level of chemical doping.

***Indicator I4.* Increase opportunities for underrepresented individuals and institutions to conduct high quality, competitive research and education activities.**

The New Mexico State University program, the Agricultural Science Summer Undergraduate Research Education and Development (ASSURED) project, targets children of migrant family workers to entice them into scientific research careers (0244179). These are students that have not been exposed to the sciences and experience an intensive summer experience in the plant sciences. Normally, these students would be working on farms harvesting crops. Instead, they are learning about plants and what it might be like to study them as a career. This type of program could radically change the life of a migrant child and end a potential poverty cycle for that child's family.

Also noteworthy are two high-quality science education activities: the "Earth Science Pipeline Project" at California State University-San Bernardino (0119934) and the "Geoscience Diversity Enhancement Project" (GDEP) at California State University-Long Beach (0119891). Both programs draw in large numbers of students from ethnic groups that are underrepresented in the geosciences. The Pipeline project has reached nearly 5,000 middle and high schools in the San Bernardino area. The GDEP program involves faculty and students from community colleges and high schools in the Long Beach area in an intensive summer geoscience research experience. These programs integrate research and education and involve minority students in programs that are relevant to their local community and to society in general.

Two programs that focus on innovative research are located at the Center for Innovative Manufacturing of Advanced Materials at Tuskegee University (9706871) and the Computational Center for Molecular Structure and Interactions at Jackson State University (9805465) Both are NSF Centers for Research Excellence in Science and Technology (CREST). The Tuskegee center is focused on cutting-edge materials research on nanoparticle polymer interactions, has produced 60 refereed publications, and involves 33 graduate and 25 undergraduate students at this historically Black institution. The Jackson State center is becoming a national leader in computational chemistry and one of the largest producers of African-American PhDs in chemistry. These programs are doing innovative research in important fields and introducing minority students to exciting careers in research that have substantial economic potential to society.

***Indicator I5.* Provide leadership in identifying and developing new research and education opportunities within and across Science and Engineering fields.**

The pioneering work of Vittay Vittal, Iowa State University, a grantee of the CNCI program ("SGER: Robust Gain Scheduled Control Design in Power Systems") offers one example (0338624). Dr. Vittal has been developing real time control techniques to prevent disruptions and improve management of the power grid. MIT's Technology Review lists "Power Grid Control" as one of the ten emerging technologies that will affect our lives and work in revolutionary ways and identifies Dr. Vittal as a research leader in the field.

Another project with potential to revolutionize lives is the Pacific Rim Applications and Grid Middleware Assembly (PRAGMA) (0216895, 0314015). PRAGMA is a partnership of 14 high-performance computing institutions to promote cooperation in grid technology and regional standards development to make grid-enabled computing and resource sharing a reality. This partnership has provided leadership in the application of computing technology to fighting global epidemics. During the recent SARS outbreak, PRAGMA assisted Taiwan in developing a cutting-edge communication access grid that linked quarantined hospitals to each other and to the most up-to-date global sources of information. The PRAGMA partnership also vividly illustrates the value of international collaborative efforts.

NSF investigators at the University of California-Irvine have assumed a leadership role in the development of a new line of research on database outsourcing (0220069). Working with IBM, the researchers are exploring techniques to insure data privacy within a database-managed system shared with other institutions. UCI and IBM have built a prototype system, the NetDB2, that allows database users to get full functionality of data management – content creation, storage, and querying applications over the Internet without the overhead of maintaining or administering the data management system. This prototype, which is being used successfully by several educational institutions, has the potential to increase access across a wide range of organizations to this important computing tool. The development of techniques to insure data privacy will have implications beyond this specific application.

In the field of science education, NSF is funding the development and dissemination of an innovative method of teaching chemistry known as Process Oriented Guided Inquiry Learning (POGIL) (0231120). This technique replaces lectures with a learner-centered approach in which students explore data, search for patterns, develop concepts to explain these patterns, and then apply these concepts to new situations. POGIL has improved student performance at institutions ranging from the University of New Mexico, a large public university, to Carleton College, a private, liberal arts college.

***Indicator I6.* Accelerate progress in selected S&E areas of high priority by creating new integrative and cross-disciplinary knowledge and tools, and by providing people with new skills and perspectives.**

The research team of Nersessian and Newstetter at Georgia Tech studied and analyzed the Biomedical Engineering Laboratories (BME), organizations already well-known for their high degree of innovation in order to unlock cognitive keys that could be not only transferred but integrated into undergraduate biomedical engineering curriculum through the NSF-funded award, "ROLE: Biomedical Engineering Thinking and Learning: The Challenge of Integrating Systems and Analytical Thinking" (0106773). "Hard-wiring" these lessons and approaches into the curriculum, one has a greater expectation of producing future student cohorts - ones better equipped to conceive of, implement, and carry to completion more complex and interdisciplinary research projects.

The work of James Zachos and his graduate students at the University of California-Santa Cruz is an example of an important type of collaborative effort between global climate modelers and scientists who look at the fossil record in deep ocean sediments (0120727). Under the auspices of a Biocomplexity in the Environment grant, the UCSC group used samples from well-preserved sediment cores from the interval known as Paleocene-Eocene Thermal Maximum (PETM), which were obtained from the NSF-supported oceanographic facility JOIDES *Resolution* deep drill vessel (9308410). The PETM occurred about 55 million years ago and led to shifts in precipitation patterns. Until recently, scientists had postulated that the PETM was a global event driven by a rise in greenhouse gas concentrations, but they lacked the tropical-latitude sediment cores required to confirm that warming truly occurred worldwide. The collaboration resulted in an article in Science (v. 302, 28 November 2003: 1551-1554) and provides important clues about the likely fate of our planet and life on the planet if anthropogenically driven global warming continues.

Two key components in accelerating progress in high priority S&E areas are the seamless integration of the social sciences and pushing "results" down to K-12 grades. Six Degrees: The Science of a Connected Age, by Duncan J. Watts, a CAREER award recipient, does both (0094162). This book is written at a level appropriate for an audience of school children and explains the structure of social networks. Via email projects, school children discover for themselves the "six degrees of separation." Watts has done more than merely introducing the public to social networks; he has developed new theory and applications of complex social networks by bringing together newly available economic and sociological data with enhanced computational methods. In so doing, he has not only drawn upon but has contributed to fields as diverse as physics and biology. This research (and resultant book) have provided people with new perspectives and critical thinking skills as evidenced by the enormous public interest in understanding social networks and how they explain such phenomena as epidemics, stock market bubbles, and personal relationships.

TOOLS

***Indicator T1.* Expand opportunities for U.S. researchers, educators, and students at all levels to access state-of the-art S&E facilities, tools, databases, and other infrastructure.**

The Institute for Mathematics and Its Applications (IMA) at the University of Minnesota is one of several excellent mathematical sciences research institutes funded by NSF (0307274, 9810289). These institutes are especially well positioned to help expand opportunities for U.S. researchers who want to explore directions in exciting new interdisciplinary areas. In June 2003, the IMA launched two activities to assist established mathematicians to make such changes and to increase the impact of their research. The first is a series of summer crash courses designed to introduce mathematical scientists without applied background to an active area of interdisciplinary research through tutorials and work with more established researchers. The inaugural course attracted 27 researchers and focused on cellular physiology. The second activity augments the existing visiting membership of the IMA during its long-term annual programs by adding a few resident memberships reserved for mathematical scientists seeking new research directions in line with program topics. The first such members participated in the 2003-2004 program on "Probability and Statistics in Complex Systems: Genomics, Networks, and Financial Engineering." These experiments—and perhaps others to follow—are fine examples of how the mathematical sciences research institutes can help to maximize the productivity and impact of mid-career researchers.

The award “Earth Science Pipeline: Recruiting and Retaining Underrepresented Ethnic Groups in the Earth Sciences” (0119934) has been successful in focusing on outreach to middle and high school students from various ethnic backgrounds that are underrepresented in the geosciences. Hands-on activities and walking tours are enhanced by the close proximity of the San Andreas and San Jacinto faults. A web page http://geology.csusb.edu/DIVGRANT/Espindex.htm not only contains links to many activities that may be used in the classroom, such as construction of shoebox models that illustrate the hypothesis of sea-floor spreading and a computer animation program that help students to make observations about special patterns where earthquakes occur, but also breaking earth science news. These students are also exposed to pictures of black smokers at hydrothermal vents on the mid-ocean ridges and the process used to measure the movements of plates using Global Positioning Systems. This ties into a local research project involving the opportunity for geology majors to work with scientists measuring elastic strain accumulation across the San Andreas and San Jacinto faults. The Southern California Earthquake Data Center uses the data to construct its Crustal Motion Map, but more importantly this project encourages young students to further their involvement in the advancement of scientific research.

The GRASP computer program at Columbia University for studying membrane proteins (9808902) makes the important study of complex electrostatic surfaces of proteins easy and even user-friendly. It has become one of the most widely used programs in structural biology, to the point where nearly every relevant publication includes a GRASP image, attesting to its widespread adoption. The three-dimensional structure of proteins allows the GRASP algorithm, developed by the staff at Columbia

University, to calculate the electrical potentials of a protein and map them onto the protein surfaces. Through much analysis, it has been accepted that these GRASP images play an important role in recognizing many protein-protein interactions. This provides the basis for understanding the physical-chemical rules that govern these interactions, and for using these rules to predict the regions on a protein's surface involved in intermolecular recognition. A web interface to a database of protein-protein interfaces (the GRASP structure server) has made this tool accessible and therefore useful to researchers and educators throughout the world.

An award to Princeton University supports an open, globally distributed platform for developing, deploying and accessing world-scale network services (0335214). PlanetLab is designed to allow rapid but short-term experiments in distributed processing and network infrastructure issues such as high availability protocols. Network services deployed on PlanetLab experience all of the behaviors of the real Internet where the only thing predictable is unpredictability (latency, bandwidth, and paths taken). In addition, PlanetLab provides a diverse perspective on the Internet in terms of connection properties, network presence, and geographic location. PlanetLab has produced a vibrant user community that is building and deploying robust content distribution networks, worm detection systems, Internet measurement tools, survivable storage systems, and Internet health monitoring tools.

Indicator T2. ***Provide leadership in the development, construction, and operation of major, next-generation facilities and other large research and education platforms.***

On November 6, 2003, scientists from North America, Europe, and Chile broke ground on what will be the world's largest, most sensitive radio telescope operating at millimeter wavelengths (0244577). ALMA, the Atacama Large Millimeter Array, will scan the millimeter and sub-millimeter region of the electromagnetic spectrum with angular resolution beyond any previous device. These are the only bands in the electromagnetic spectrum in which we can detect cold dust and molecules far away in young, high-redshift galaxies in the early Universe, and nearby in low-temperature cocoons of protostars in our own Galaxy. The ALMA science program includes probing the origins of galaxies, stars, and planets. It is likely to provide new breakthroughs of comparable impact as the Hubble Space Telescope has had in its distinct shorter wavelength region of the spectrum. ALMA is located east of the village of San Pedro de Atacama in northern Chile. This is an exceptional site for (sub)-millimeter astronomy, possibly unique in the world. The median precipitable water-vapor content of the atmosphere is only about 1 mm, and the topography of the site can accommodate the large configurations required for ALMA. Site characterization studies have been underway since 1995, a collaborative effort between Europe, the United States, and Japan. NSF support clearly shows leadership in one of the forefront new facilities in the world.

The Laser Interferometer Gravitational Wave Observatory (LIGO) was completed with NSF Major Research Equipment (MRE) support in 2001 (0107417). Data started to be taken in 2002 for the first broad search for astrophysical sources of gravitational waves with sensitivity never before attained. It is able to measure ripples in spacetime that would be produced by cataclysmic astronomical events in galaxies well beyond our own. This grant provides the support to operate and manage LIGO for a period of five years. It is essential that NSF plan for such operations support for each facility in which it participates. With unpredictable budgets this becomes very difficult but essential in order to reap the benefit of the investment in the equipment. The first scientific papers have been submitted for publication this year from the international collaboration, which includes 42 institutions with members from Canada, Europe, and Japan. Part of the grant provides for R&D into the technology of this state of the art device. Partnerships with industry are planned to advance the capabilities of the current LIGO. There is also significant educational and public outreach. It must be noted that although LIGO is clearly a major, next-generation facility of world class, it is high risk in that there is no guarantee that gravity waves will be found at its current level of sensitivity.

The Sloan Digital Sky Survey (SDSS) project is a major inter-agency and private-foundation partnership funded ground-based effort to map 10,000 square degrees of the sky at a spatial resolution of 0.40 arcseconds in the spectral bands at: 0.35, 0.48, 0.62, 0.76 and 0.91 micrometer wavelengths with a signal to noise ratio of 10 for 22.3 stellar magnitudes at 0.62 micrometers wavelengths (0096900). The survey goals are to record 900,000 field galaxies down to red magnitudes of 17.7 The science goals are to analyze the large scale structure to determine information about the evolution of the universe. However, the huge data set obtained contains much information on a wide variety of discoveries. For example, last year the data on the clustering corroborated the conclusions on dark matter and dark energy obtained from cosmic microwave radiation and supernovae. Often news from SDSS reaches the popular press. The SDSS has passed the halfway point in its goal of measuring one million galaxy and quasar redshifts. The first public data release from the SDSS, called DR1, contained about 15 million galaxies, with redshift distance measurements for more than 100,000 of them. The second, DR2, was made available to the astronomical community in early 2004. This research project encourages international scientific collaboration and places the United States at the forefront of cosmological astrophysics.

Magma Reservoir-Conduit Dynamics Revealed by Borehole Geophysical Observatory and Continuous GPS (0116067, 0116826, 0116485) is a collaboration among scientists in the United States and the United Kingdom. Project CALIPSO (Caribbean Andesite Lava Island Precision Seismo-geodetic Observatory) had already studied the Soufriére Hills Volcano on the Caribbean island of Montserrat, which had its latest eruption on July 13, 2003. The work is being done in partnership with the Montserrat Volcano Observatory (MVO). This project deployed ultra-sensitive strainmeters and seismometers in four 200 m deep boreholes and GPS at surface sites. Since all the equipment was in place when the eruption took place, the opportunity to learn is unprecedented.

Indicator T3. ***Develop and deploy an advanced cyberinfrastructure to enable all fields of science and engineering to fully utilize state-of-the-art computation.***

Two clusters of the 44 nuggets within this indicator illustrate the achievements under this goal:

(1) High-performance (supercomputer) facilities and their supporting infrastructure. Two nuggets selected: PACI Program leading edge sites; and TeraGrid.
(2) High-speed network development to deliver these resources to research collaborations around the world. Two nuggets selected: Euro-Link: High Performance Network between US and Europe; and TransPac - Internet services for Trans-Pacific connectivity.

(1) Supercomputer Facilities. The massive PACI Program (Partnerships for Advanced Computational Infrastructure) encompasses the three supercomputer facilities, the National Computational Science Alliance (NCSA) in Illinois (9619019), the Terascale Computing System in Pittsburgh (9619020), and the National Partnership for Advanced Computational Infrastructure (NPACI) in San Diego (0085206). Each of these facilities has demonstrated remarkable innovation and organization, including educational outreach and training as well as their primary function of serving a broadening constituency of researchers. One facility (NCSA) reported 61 million CPU hours of usage in one year, a 43% growth over the previous year. The computational service offered by these facilities is essential to scientific advance in many areas. Notable successes include the discovery of a new brown dwarf star by data mining at SDSC within a huge astronomical database (0122449) and near real-time tele-immersion employing the Pittsburgh Supercomputing Center (0121293). The development of the Terascale Computing System (0307136, 0332116) and the TeraGrid (0122272), a distributed infrastructure incorporating all the supercomputing centers aiming for 20 Teraflop performance, seems exactly the correct direction for the scientific community.

(2) High-speed Networks. It is self-evident that these immense computational resources need networks that can deliver them to scientists at unprecedented speeds. EuroLink (9730202) and TransPAC (9730201) are exemplary programs that have achieved five Gbps via innovative optical network architectures, the former linking North America to Europe, and the latter to Tokyo. The connection in the United States is to NSF's very high-performance Backbone Network Services (vBNS). Innovations in administrative structures, hardware, and software are all necessary to advance the state of this art. Especially notable are the small research projects that are pushing the networking envelope and feeding into the national facilities, such as the five-fold speed increase of FAST TCP (0113425), and the thousand-fold energy reduction of narrow-beam wireless (0225379).

***Indicator T4.* Provide for the collection and analysis of the scientific and technical resources of the U.S. and other nations to inform policy formulation and resource allocation.**

Support for the development of textual data mining tools enables NSF to make better use of the mass of data it houses about its awards and reports (0211396). Tools of this kind may help increase the return on investment in the nation's research by dramatically improving the use of information about projects that NSF undertakes across organizations and time. The approach incorporates latent semantic indexing technology that allows for context-based searching in contrast to standard keyword searching or Google's voting scheme. An example was cited of how NSF used these tools to amass information for about eight years of awards involving mathematics education activity for use by its EHR directorate. Information retrieval, generally speaking, is one of the great challenges in today's electronic world, and it is gratifying to see NSF develop and apply such special purpose tools to increase its own efficiency of operation.

A popular and invaluable report, Science and Engineering Indicators 2004, provides a variety of indicators on the state of science and engineering in the United States and, increasingly, includes a variety of international comparisons. The information in this report is of great value to policymakers in government, as it should be, but it is also important for educators and administrators who need to track demographic and other trends over time. The report appears biennially and is widely disseminated.

The health of industrial research in the United States is critical to the nation not only from a research perspective but also because of its implication for the economy. It is to be commended that NSF continues to devote resources to improving the statistical and methodological design of its Survey of Industrial Research and Development. This will assure that the information used by policy makers, among others, will be of the highest quality. NSF is working in collaboration with the Census Bureau's Economic Statistical Methods and Programming Division and with the Committee on National Statistics (CNSTAT) at the National Academy of Sciences.

Another research project studied the determinants of patenting behavior and the effect of patenting on R&D efforts in the United States and Japanese manufacturing sectors and also the effect of the patenting and licensing of research tools on biomedical innovation. Based on careful modeling of data, a number of findings were reached that have implications for policymakers in both government and industry. A summary of the research was widely disseminated in Science magazine ("Working Through the Patent Problem," v. 299, p. 1021).

***Indicator T5.* Support research that advances instrument technology and leads to the development of next-generation research and education tools.**

The current trend in electronics is toward the smaller, faster, and cheaper. As size scales decrease and operation speeds increase rapidly, the physics of the materials used for constructing electronic components becomes more and more important. More than just understanding the basic properties of materials, actually observing the changes taking place during the construction of electronic materials has become a real need. Karl Ludwig of Boston University is developing a new instrument that makes use of surface scattering of X-rays to provide real-time observations of surface growth and other changes taking place within a substrate during processing (0116567). Instruments such as this will lead to a greater understanding of the physics of materials under a wide range of processing conditions.

One of the more surprising and exciting results of recent geoscience research is the wide range in conditions under which life has been found not only to exist but to flourish. Environments ranging over vast ranges in temperature, pressure, and chemical composition have been found to harbor living organisms. Such discoveries give hope and encouragement to those who would look for life beyond Earth, either throughout the solar system or around nearby stars. One class of instrument that has played a large role in this work has been deployable electrochemical analyzers that can operate under conditions that human researchers cannot. One such instrument is an in situ electrochemical analyzer (ISEA) developed by researchers at the University of Delaware to be deployed at any ocean depth for remote aquatic experiments (0136671). This instrument allows the simultaneous measurement of many different biologically important elements and compounds within the environments of undersea hydrothermal vents. Such measurements are of great importance for monitoring the “health” of ecosystems, which have developed in these environments. The ability to make real-time measurements in such hostile (to humans) environments will pay rich dividends in terms of understanding the development and long-term sustainability of such ecosystems.

The need for monitoring large and changing environments covers such diverse fields as ecology, atmospheric science, public health, and national security. Static, non-autonomous sensors do not provide investigators with the power and flexibility that they need. Research at the Center for Embedded Networked Sensing at UCLA seems to have overcome these difficulties (0120778). Utilizing a network of fixed and mobile nodes, a self-aware sensor network is created that can reconfigure itself in order to continually optimize its performance. Successful tests of the system have already been run, collecting data from within a forest environment not easily accessible by humans. The project also impacts K-12 education in that it provides students access to remote sensors that they may use to carry out investigations of their own.

SUPPORTING INFORMATION FOR FY 2004

Performance Reporting Requirements and Where to Find Them in Our Report

The Government Performance and Results Act of 1993 requires each Federal agency to report to the President and the Congress on its performance for the previous fiscal year. According to OMB Circular No. A-11 Part 6, Section 230.2, dated 16 July 2004, each report must include the following elements[2]:

1. *A comparison of your actual performance with the projected (target) levels of performance as set out in the performance goals in your annual performance;*
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, your recommended action regarding an unmet goal where you have concluded it is impractical or infeasible to achieve that goal;*
4. *An evaluation of your performance budget for the current fiscal year, taking into account the actual performance achieved;*
5. *An assessment of the reliability and completeness of the performance data included in the report; and*
6. *Actual performance information for at least four fiscal years.*

Other features as they apply to the agency:

Program evaluations[3];
Information on use of non-Federal parties;
Classified appendices not available to the public;
Budget information.

[2] Elements 1-4 and 6 are provided with each goal discussed in our report. Element 5 is discussed in Section V.
[3] See Section IV.

III. NSF GOALS

Introduction to Section III: NSF Goals

To accomplish the NSF mission to promote the progress of science, NSF invests in the most capable people, supporting their creative ideas, and providing them with cutting-edge research and education tools. Within the NSF, the agency strives to maintain a diverse, agile, results-oriented cadre of NSF knowledge workers and leadership in state-of-the-art business processes, tools and technologies.

NSF has four strategic outcome goals. These are:

PEOPLE – *A diverse, competitive, and globally engaged U.S. workforce of scientists, engineers, technologists and well-prepared citizens.*

Leadership in today's knowledge economy requires world-class scientists and engineers and a national workforce that is scientifically, technically and mathematically strong. Investments in *People* aim to improve the quality and reach of science, engineering, and mathematics education and enhance student achievement. Each year, NSF supports more than 200,000 people – teachers, students, and researchers at every educational level and across all disciplines in science and engineering. Embedded in all NSF programs are efforts to build a more inclusive, knowledgeable, and globally engaged workforce that fully reflects the strength of the nation's diverse population.

IDEAS – *Discovery across the frontier of science and engineering, connected to learning, innovation and service to society.*

Investments in *Ideas* are aimed at the frontiers of science and engineering. They build the intellectual capital and fundamental knowledge that drive technological innovation, spur economic growth, and increase national security and welfare. They also seek answers to the most fundamental questions about the origin and nature of the universe and humankind.

TOOLS – *Broadly accessible, state-of-the-art S&E facilities, tools, and other infrastructure that enable discovery, learning and innovation.*

State-of-the-art tools and facilities boost the overall productivity of the research and education enterprise. NSF's strategy is to invest in a wide range of instrumentation, multi-user facilities, distributed networks, digital libraries and computational infrastructure that add unique value to research and are accessible and widely shared among researchers across the nation.

ORGANIZATIONAL EXCELLENCE – *An agile, innovative organization that fulfills its mission through leadership in state-of the-art business processes.*

Excellence in managing NSF underpins all of the agency's activities. Most importantly, this leadership depends on maintaining a diverse, agile, results-oriented NSF workforce that operates in a continuous learning environment. NSF's strategy focuses directly on the agency's leadership in core business processes, such as E-government and financial management. NSF's investments in administration and management must respond both to the growing complexity of its workload and to new requirements for accountability and transparency in its processes.

NSF also has an additional 25 performance goals associated with the Performance Assessment and Rating Tool (PART) developed by the Office of Management and Budget. Information concerning the PART process can be found at **http://www.whitehouse.gov/omb/part/2004_program_eval.pdf**. The performance goals and achievement with respect to these goals are found following the strategic outcome goal with which they are most closely associated.

NSF assessment activities are based on an OMB-approved alternative-reporting format that utilizes external experts for qualitative, retrospective evaluations of Foundation outcome results. In years prior to FY 2002, NSF used external independent assessments of NSF's outcome goal indicators provided by Committees of Visitors and Directorate Advisory Committees[4]. These committees provided assessment at program, divisional, or directorate levels.

In FY 2002, NSF created a new external advisory committee – the Advisory Committee for GPRA Performance Assessment (AC/GPA) – to provide advice and recommendations to the NSF Director regarding the Foundation's performance under the Government Performance and Results Act (GPRA) of 1993.

For FY 2004, Organizational Excellence (OE) is a specific NSF strategic outcome goal. This goal was included as a strategic outcome goal at the urging of NSF's Advisory Committee for Business and Operations (AC/B&O) since it is a key enabling tool for the outcome goals of People, Ideas, and Tools

In its FY 2003 report, the AC/GPA recommended that NSF should consider an approach that involved a significant component of "self study." They envisioned that this would involve a greater number of NSF staff, would be based on NSF's strategic goals and indicators, would be data driven, and would provide key information at multiple levels of detail. NSF adopted this approach for the Organizational Excellence goal. Early on, it was determined that the AC/B&O would provide an assessment of three of the indicators for the OE goal, Human Capital, Technology-Enabled Business Processes, and Performance Assessment. The AC/GPA would conduct an assessment of the Merit Review indicator.

The charge to the NSF AC/GPA asked for development and transmittal to NSF of a report that included:

An assessment of results for indicators associated with the strategic outcome goals of People, Ideas, Tools, and the merit review indicator for the Organizational Excellence goal. (The other three indicators for this goal were assessed by the Advisory Committee on Business and Operations – see above);
Comments on the quality and relevance of award portfolios; and
Comments on innovative, high risk, and multidisciplinary research and education.

The format of Section III is the following:

An NSF assessment of performance with respect to each strategic outcome goal;
Comments by the AC/GPA concerning the strategic outcome goal;
For each indicator or area of emphasis associated with a strategic outcome goal:
Comments by the AC/GPA; and
An NSF assessment of performance with respect to related PART performance goals.

[4] See Section IV for further details on these committees.

The following AC/GPA comments concerning the quality and relevance of NSF-supported research as well as AC/GPA comments on innovative, risky, and multi-disciplinary research and education supported by NSF are excerpted from the AC/GPA Report. The report is available at http://www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf04216.

AC/GPA Comments on Quality and Relevance

"The Committee concluded that the quality of the portfolio was high in the three outcome goals of People, Ideas, and Tools and that the Organizational Excellence goal demonstrated quality and innovativeness in its activities. The diversity of projects in the research portfolio is remarkable, representing a spectrum of mechanisms to support discovery that includes individuals, teams of various sizes, and centers as well as facilities and other infrastructure (defined broadly).

NSF continues to make significant contributions toward the achievement of important national goals and, in doing so, is serving the needs of its constituents in the scientific community as well as the the broader needs of science, engineering and education as human endeavors. In addition, NSF is clearly becoming a high-performing organization. Its focus on organizational excellence as a strategic outcome goal is a welcome and necessary complement to the other goals and will enable the Foundation to continue to make contributions to science, engineering, mathematics, and education and use the nation's investments wisely and efficiently.

The Committee wants to reiterate that the synergy of the four outcome goals is a major source of their power. Discoveries at the frontiers of knowledge are both supportive of and dependent on progress in effectively linking education and research, the development of new instrumentation, facilities, and other tools, and the education and training of a highly qualified cadre of individuals motivated and excited by science, engineering, and mathematics. Organizational excellence in people, processes, and assessment enables all three. The Committee felt that it was important to continue to make this point, as it has done in its two previous reports.

The Committee concluded that the high quality, relevance, and performance of the NSF portfolio is principally due to NSF's use of a rigorous process of competitive merit review in making awards. NSF has continued to make progress in implementing its two principal review criteria – intellectual merit and broader impacts. There is a heightened awareness and increased use of both criteria by proposers, reviewers, and program officers. Yet more work remains, particularly in improving the quality of the responses to the broader impact criterion. There are negative forces, such as Congressionally-directed appropriations, that have the effect of distorting the merit review process and adversely impacting future NSF performance. NSF and its external stakeholders, both within and outside the Federal government, should work together to resist the corrosive influence of these forces and to continue to support and expand competitive merit review across the Federal government's research portfolio."

AC/GPA Comments on Innovative, High Risk, and Multidisciplinary Research and Education

"With regard to innovative, high risk, and multidisciplinary research and education, the Committee saw evidence of accomplishment. However, the Committee notes that the term "high risk" with regard to research is still not clearly defined.[5] It was not always clear to the Committee what characteristics NSF staff (program officers) making the designation of "high risk" were using to indicate which specific

[5] The Committee prefers the term "bold" rather than "high risk" to describe this kind of research. "High risk" is somewhat of a term of art and could convey an inappropriate impression about research that is extremely novel or pathbreaking. A committee member noted that one NSF directorate, Computer and Information Science and Engineering, already uses the term "bold" to describe such research.

projects in the portfolio were deemed to be high risk. One subgroup attempted to develop criteria for this term so as to more clearly delineate examples from its portfolio. We offer those criteria as ones that NSF might consider as part of a broader discussion of this issue. "High risk research" might be assessed based on:

The probability that the project can be conducted as defined.
The level of assurance that the innovation will have the desired outcome.

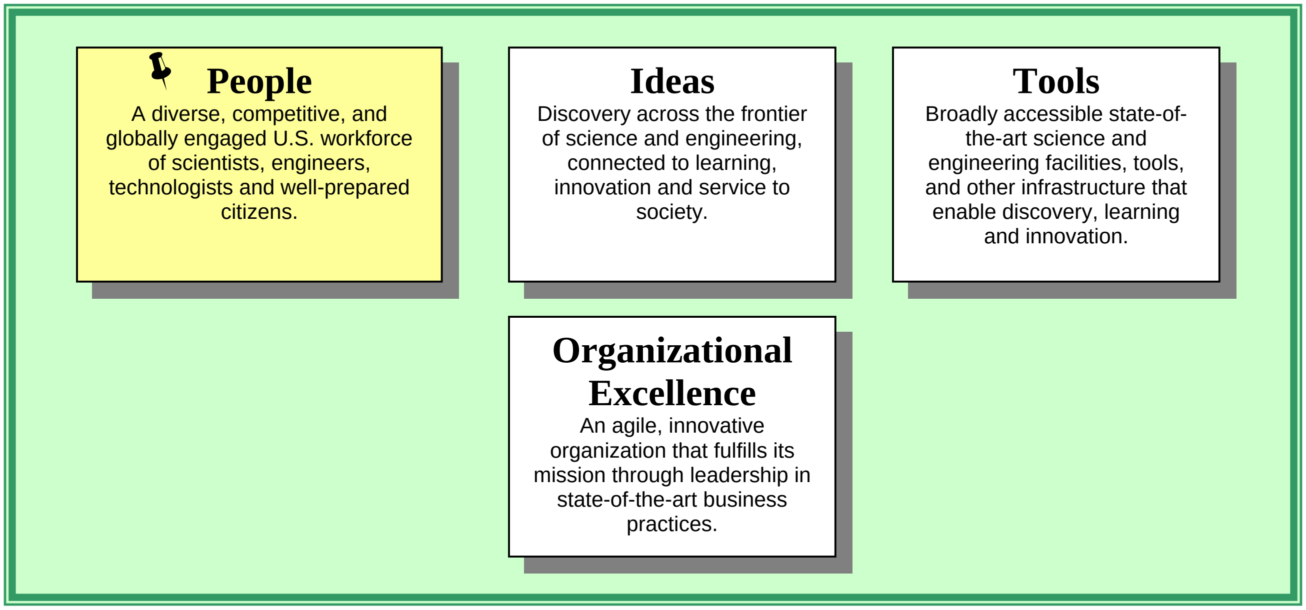
Projects may be classified as high risk not only because of the degree and/or nature of the innovation but also solely on the origin of the proposal (e.g., new researcher, context of the project.) In order to probe this more deeply, the People subgroup examined the COV reports for five programs in the Directorate for Education and Human Resources: Course Curriculum and Laboratory Improvement (CCLI), Teacher Enhancement (TE), Graduate Research Fellowship Program (GRFP), Advanced Technology Education (ATE), and Gender Diversity in STEM Education. In our analysis, we concluded that there is considerable uncertainty among COV responses regarding the operational meaning of the term "high risk" because in response to the question "Does the program portfolio have appropriate balance of high risk proposals?," three of the COVs responded "Yes," one said "No," and others said "Maybe" or gave no response. The single "No" response from TE reflected an approach that defined Small Grants for Exploratory Research (SGER) as high risk and then concluded that there were an insufficient number of them.

The Committee believes that this issue is important enough to warrant attention by the National Science Board. No obvious formula exists to guide NSF as to the fraction of the portfolio that should be "high risk" (or "bold.") However, we can say without hesitation that it is vital that the overall portfolio contain an appropriate amount of "bold" research and that the definition of such research must be clear and widely understood by NSF's key stakeholders. We also recognize that there is always a tension in finding and funding such research relative to other priorities and, where possible, we suggest that NSF should do more. However, we also offer a caution: the need to show "results" and, indeed, this GPRA process, should not make the finding and funding of such research more difficult. There must be an appreciation by all who support the use of taxpayer money for good and valid national purposes that advancing the frontiers of human knowledge requires, indeed demands, that our research portfolio contain investments with long odds of success (but, if successful, with the ability to fundamentally transform our understanding).

The Committee also believes that it would be useful to separate the characterization of NSF-supported research into that which is "innovative," that which is "high risk" (bold), and that which is multidisciplinary. The phrasing of the charge to the Committee seemed to indicate that we were to assess research that met all three criteria simultaneously (innovative AND high risk AND multidisciplinary). We found many instances where projects met one or two of the criteria but few where all three were met. These criteria are not mutually exclusive and all have intrinsic value in a broad and balanced portfolio. We encourage NSF to consider this change for future years. With regard to multidisciplinary research, the Committee notes that the encouraging trend continues wherein multiple NSF directorates collaborate to fund a suite of related research activities (e.g., mathematics and biology, environmental research, cyberinfrastructure). While the relative level of these types of collaborations within NSF may be able to serve as a proxy for investment in multidisciplinary research and education, more definitive analyses of the long term impact of these investments is needed."

III. NSF GPRA GOALS

A. PEOPLE



PEOPLE STRATEGIC OUTCOME GOAL: A diverse, competitive, and globally engaged U.S. workforce of scientists, engineers, technologists and well-prepared citizens.

✓ Goal 1 Achieved

Leadership in today's knowledge economy requires world-class scientists and engineers and a national workforce that is scientifically, technically and mathematically strong. Investments in *People* aim to improve the quality and reach of science, engineering, and mathematics education and enhance student achievement. Each year, NSF supports more than 200,000 people – teachers, students, and researchers at every educational level and across all disciplines in science and engineering. Embedded in all NSF programs are efforts to build a more inclusive, knowledgeable, and globally engaged workforce that fully reflects the strength of the Nation's diverse population.

Annual Performance Goal 1: Our performance for this goal is successful when, *in the aggregate*, results reported in the period FY 2004 demonstrate significant achievement in the majority of the following indicators:

- Promote greater diversity in the science and engineering workforce through increased participation of underrepresented groups and institutions in all NSF programs and activities.
- Support programs that attract and prepare U.S. students to be highly qualified members of the global S&E workforce, including providing opportunities for international study, collaborations and partnerships.
- Develop the Nation's capability to provide K-12 and higher education faculty with opportunities for continuous learning and career development in science, technology, engineering and mathematics.

- Promote public understanding and appreciation of science, technology, engineering, and mathematics, and build bridges between formal and informal science education.
- Support innovative research on learning, teaching and mentoring that provides a scientific basis for improving science, technology, engineering and mathematics education at all levels.

RESULT FOR PERFORMANCE GOAL 1: NSF achieved this goal. External experts provided examples of significant achievement during FY 2004 reporting. Comments by the AC/GPA and examples they selected are presented for each of the performance indicators and areas of emphasis for this goal.

Implications for the FY 2005 Performance Plan: This goal will be continued in FY 2005.

PEOPLE: Comments by the Advisory Committee for GPRA Performance Assessment (AC/GPA)

The following statements concerning NSF achievement with respect to the indicators for the PEOPLE goal are excerpted from the AC/GPA Report on NSF's PEOPLE portfolio. Additional comments as well as examples in support of significant achievement for each indicator are available at http://www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf04216.

"The Committee concluded that there is significant achievement in all indicators of the PEOPLE strategic outcome goal, which is to create "a diverse, competitive, and globally-engaged U.S. workforce of scientists, engineers, technologists and well-prepared citizens." The Committee concluded that NSF had met the goal for each indicator in making investments in individuals, institutions, and collaborations. This decision was based on the collective review and discussion of each indicator summary.

Quality and relevance: Based on the summary of COV reports and the review of accomplishments (nuggets) the overall quality of projects was determined to be high and relevant to the People strategic outcome goal. COVs appear to be paying significant attention to the issue of quality and where concerns were noted, NSF is being both responsible and responsive to the recommendations of these review groups.

High risk, innovative, multidisciplinary projects: Overall, the Committee concluded that there were many nuggets that demonstrated a high level of investment in interdisciplinary, innovative/creative, and high-risk research. The Committee also believed that collaboration was a key criterion on which to judge the portfolio for this strategic outcome goal. Thus, we have added it for purposes of evaluating NSF's investments. We find that there are numerous and rich examples of collaborative activities.

Committee reviewers of the PEOPLE indicators were unanimous in their observation that the overall quality and relevance of the nuggets available for review were high. Selections were made of those accomplishments that were believed to best represent each of the five indicators. Although the rationale for nugget selection varied among the panel members within the context of each of the indicators, several common themes emerged for selection:

> Accomplishments that represented the diversity of projects (e.g., people, topic, geographic, project type, culture)
>
> Accomplishments that demonstrated broad impact of project (e.g., collaborations, number of participants)"

"Other Issues to Address Related to the PEOPLE strategic outcome goal:

NSF should strongly consider encouraging the increased use of the Research Experiences for Undergraduates (REU) Program to encourage more involvement of undergraduates in projects related to People. This is especially true for international and multicultural projects.

In order to expand the number of projects related to the preparation of U.S. students to be highly qualified members of the global S&E workforce, faculty should be encouraged to interact with existing offices and organizations on their campuses that coordinate study abroad.

NSF should consider bringing to the forefront excellent activities related to the PEOPLE goal as models even if NSF does not fund these programs.

NSF needs to support research on the factors that affect the ability to attract graduate students to the United States. Currently there is mostly anecdotal information that does not lend itself to the development of strategies to address the issue in ways that will be effective in the long term."

INDICATOR 1: Promote greater diversity in the science and engineering workforce through increased participation of underrepresented groups and institutions in all NSF programs and activities.

RESULT: ***Demonstrated significant achievement.***

"The national challenge: According to Science and Engineering Indicators 2004, members of underrepresented minorities (American Indians/Alaska Natives, African Americans, and Latino/a Americans) made up only seven percent of the S&E workforce in 1999, but 24 percent of the U.S. population. Women constituted only 24.7 percent of the college-educated workforce in S&E occupations in 1999, but 46 percent of the total U.S. workforce. According to the 2002 report of the Committee on Equal Opportunities in Science and Engineering (CEOSE), persons with disabilities made up 11.6% of the U.S. workforce in 1999, but only 5.5% of the S&E workforce. The nation is not getting full benefits from the talents of these groups. Overall, the participation of women in S&E careers increased during the 1990s, and the participation of underrepresented minority groups remained about the same.

Furthermore, if these groups continue to be underrepresented in science and engineering, other groups within the United States are not likely to fill in the gaps. The number of men earning bachelor's degrees in science and engineering fields has been approximately constant since 1975. The number of women earning bachelor's degrees in S&E fields has been rising steadily, particularly since 1990, but not as fast as the number earning bachelor's degrees in other fields. For white Americans, the number of bachelor's degrees earned per thousand 20-24 year olds has been declining since the mid-1990s, but rising steadily since 1989 for members of the underrepresented racial and ethnic groups. Persons with disabilities earned only 1.2% of U.S. doctorates in 2000. (All data from the CEOSE 2002 report.)

The NSF response: NSF has actively taken on the challenge of recruiting these underrepresented groups into science, technology, engineering, and mathematics (STEM) careers through a wide array of special programs and encouragement through all programs. The FY 2005 NSF Budget Request to Congress includes $498 million for programs that support individuals, including both master teachers for school classrooms and graduate support for men and women entering S&T careers. NSF requests $172 million for support to institutions, and $393 million for investment in collaborations.

Assessing Results: Under this performance indicator, NSF is committed to promoting greater diversity by raising the participation of underrepresented groups and institutions in its own programs."

INDICATOR 2: Support programs that attract and prepare U.S. students to be highly qualified members of the global S&E workforce, including providing opportunities for international study, collaborations and partnerships.

RESULT: *Demonstrated significant achievement.*

"NSF and NSF investigators have clearly found novel projects and ways in which to prepare U.S. students to learn about and participate in international activities. Five nuggets were selected representing two distinct types of projects to illustrate the range of activities and potential effectiveness of research activities in addressing this specific goal. All of the nuggets selected reflect high levels of risk, innovation and collaboration given the diverse language, culture, and political barriers that had to be overcome to accomplish these projects."

INDICATOR 3: Develop the Nation's capability to provide K-12 and higher education faculty with opportunities for continuous learning and career development in science, technology, engineering and mathematics.

RESULT: *Demonstrated significant achievement.*

"NSF has funded a variety of projects to achieve the goal of providing K-12 and higher education faculty opportunities for continuous learning and career development in science, technology, engineering and mathematics. Research Experience for Teachers (RET), CAREER awards, astronomy and astrophysics postdoctoral fellowships, Presidential Early Career Awards for Scientists and Engineers (PECASE), Small Grants for Exploratory Research (SGER), ADVANCE Fellows awards to help individuals reenter the science and engineering workforce, and the Alliance for Graduate Education and the Professoriate (AGEP) are examples of programs which are helping to achieve NSF's goals. In most cases, these programs support individual professionals or small groups of teachers and faculty. The decision not to include them as examples in this report in no way minimizes the impact they have had on development of faculty.

Likewise, researchers and educators from many colleges and universities are utilizing facilities of the supercomputer centers funded by NSF through NPACI (The National Partnerships for Advanced Computational Infrastructure) and PACI (Partnerships for Advanced Computational Infrastructure), and their Education, Outreach and Training Programs. These outstanding programs are not among the nuggets selected for illustration in this report since they are more appropriately included in the IDEAS category. However, their contribution to professional development is significant.

On the other hand, considering the importance of community colleges, HBCUs and minority serving institutions in educating the future STEM workforce, it was surprising that of the 97 nuggets in the pool of nuggets provided by NSF for this indicator, no HBCU, and only two community colleges and two minority serving institutions were primary grantees. Participation by faculty from underserved populations was mentioned in several programs, but data were insufficient to evaluate the overall impact of these programs on minority populations."

INDICATOR 4: Promote public understanding and appreciation of science, technology, engineering, and mathematics, and build bridges between formal and informal science education.

RESULT: ***Demonstrated significant achievement.***

“Many NSF-funded projects have led to significant achievements in the areas of education and public outreach. Three themes emerged from the nuggets in this category: high public interest/information transfer, general public doing science, and education.”

High Public Interest – Information Transfer

“There are some areas of science, such as astronomy, exploration, and health, which attract public interest more than some other areas. The impact of these projects generally is based on the transfer of information to the general public, rather than the active involvement of citizens or students in the scientific process. Other nuggets, not discussed here in detail, describe products as varied as planetarium shows, IMAX movies, PBS television series, children’s books, and websites.”

General Public Doing Science

“Somewhat more unusual are projects where the general public is asked to do something more than just read about science, or watch videos.”

Education

“NSF has funded a fairly extensive number of curriculum or program development projects whose aim is to reach out to underrepresented groups. A target audience is identified in a particular geographical area. The interests of the PIs lead to the development of a curricular unit or after-school program that relates to some discipline. In some cases the discipline is one whose community believes, often with some justification, that it is underrepresented in the school curriculum. The teaching techniques used in these projects communicate a very different vision of science than is sometimes done in middle and high school where teacher-talk (lecturing) is the predominant mode of teaching.”

INDICATOR 5: Support innovative research on learning, teaching and mentoring that provides a scientific basis for improving science, technology, engineering and mathematics education at all levels.

RESULT: ***Demonstrated significant achievement.***

“The nuggets reviewed were very broad in their scope and spanned the learning experience of pre-school children to graduate students, doctors, and scientists. The diversity of nuggets in terms of age, race, and geography was impressive. The nuggets demonstrate diversity of ideas and were impressive in their creativity. While many of them point out that the projects are research based, there were very few projects focused exclusively on education research. Some projects are focused on a single discipline, while the majority exemplifies the collaborative and interdisciplinary nature of NSF awards."

Annual Performance Goal 2: Number of U.S. students receiving fellowships through Graduate Research Fellowships (GRF) and Integrative Graduate Education and Research Traineeships (IGERT).

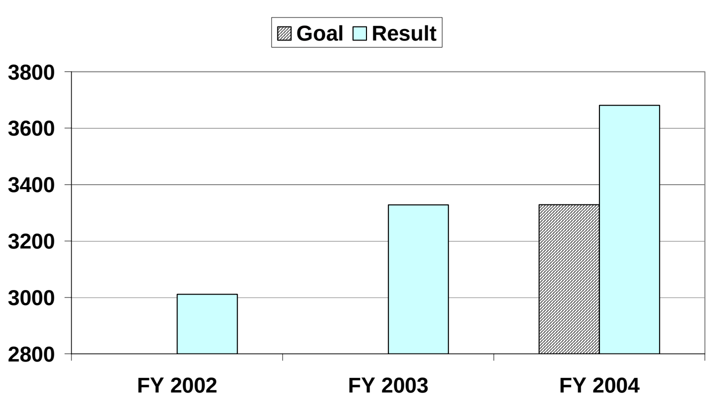
✓ Goal 2 Achieved

The National Science Foundation (NSF) seeks to ensure the vitality of the human resource base of science, mathematics, and engineering in the United States and to reinforce its diversity. A competition is conducted for Graduate Research Fellowships, with additional awards offered for women in engineering and computer and information science. NSF Graduate Fellowships offer recognition and three years of support for advanced study to outstanding graduate students in the mathematical, physical, biological, engineering, and behavioral and social sciences, including the history of science and the philosophy of science, and to research-based Ph.D. degrees in science education.

The Integrative Graduate Education and Research Traineeships (IGERT) program has been developed to meet the challenges of educating U.S. Ph.D. scientists, engineers, and educators with the interdisciplinary backgrounds, deep knowledge in chosen disciplines, and technical, professional, and personal skills to become in their own careers the leaders and creative agents for change. The program is intended to catalyze a cultural change in graduate education, for students, faculty, and institutions, by establishing innovative new models for graduate education and training in a fertile environment for collaborative research that transcends traditional disciplinary boundaries. It is also intended to facilitate greater diversity in student participation and preparation, and to contribute to the development of a diverse, globally-engaged science and engineering workforce.

NUMBER OF U.S. STUDENTS RECEIVING FELLOWSHIPS THROUGH GRF AND TRAINEESHIPS THROUGH IGERT.

	FY 2002	FY 2003	FY 2004	FY 2005
Goal			increase	increase
Result	3011	3328	**✓3681**[6]	



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN: This goal will be continued in FY 2005. However, it may be revised in the future to include active students in NSF graduate fellowship and traineeship programs.

[6] For this report, NSF is only including funded GRF and IGERT recipients and has revised FY 2002 and FY 2003 accordingly. Prior numbers had also included active students in these programs even if they were not currently funded.

Annual Performance Goal 3: Stipend level for Graduate Research Fellowships (GRF) and Integrative Graduate Education and Research Traineeships (IGERT) awards.

✓ Goal 3 Achieved

The National Science Foundation (NSF) seeks to ensure the vitality of the human resource base of science, mathematics, and engineering in the United States and to reinforce its diversity. A competition is conducted for Graduate Research Fellowships, with additional awards offered for women in engineering and computer and information science. NSF Graduate Fellowships offer recognition and three years of support for advanced study to outstanding graduate students in the mathematical, physical, biological, engineering, and behavioral and social sciences, including the history of science and the philosophy of science, and to research-based PhD degrees in science education.

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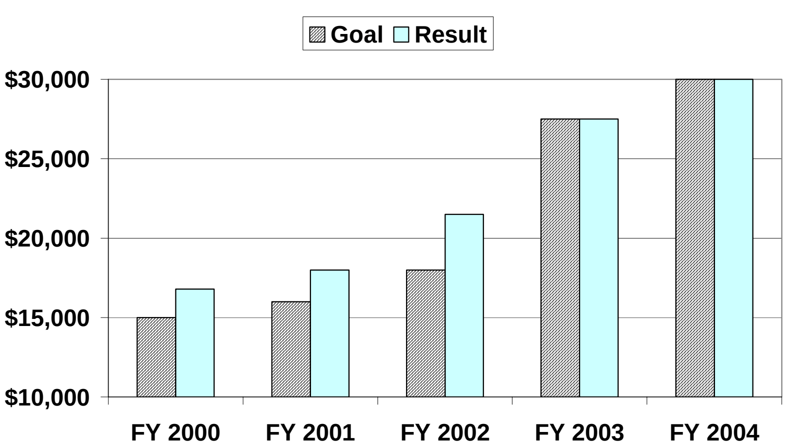
STIPEND LEVEL FOR GRF AND IGERT AWARDS (DOLLARS/YEAR)

	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Goal	$15,000	$16,000	$18,000	$27,500	$30,000	
Result	$16,800	$18,000	$21,500	$27,500	✓**$30,000**[7]	

Stipend Level for GRF and IGERT Awards (dollars/year)



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN: NSF is replacing, in FY 2005, PART program award size and duration efficiency goals with goals that combine merit review quality and the time it takes to process proposals. Therefore, this goal will not be continued as a PART goal.

[7] The goal of $30,000 is achieved during the 2004-2005 Academic Year, part of which falls in FY 2004. All new GRF and IGERT awards for academic year 2004-2005, funded in fiscal year 2004, were funded at the 30,000 level. While NSF has processes in place to provide sufficient funds to institutions (colleges and universities) to support students at the stipend level, the institutions are responsible for ensuring that the students receive the correct stipend award level.

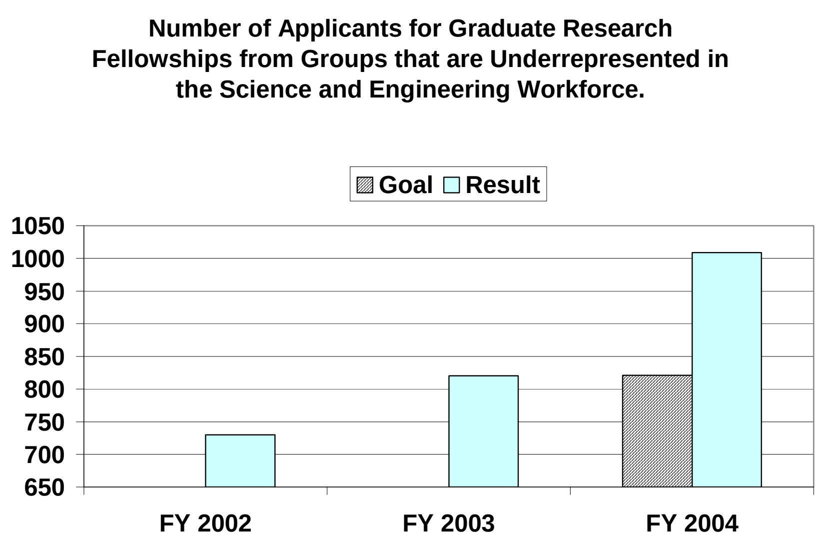
Annual Performance Goal 4: Number of applicants for Graduate Research Fellowships from groups that are underrepresented in the science and engineering workforce.

✓ Goal 4 Achieved

Graduate Research Fellowships are NSF's flagship investment in graduate education and training, and outreach efforts to increase the number of applicants from underrepresented groups are an ongoing priority. As with all demographic goals, the data come from voluntary self-reporting. This year 99% of applicants reported on race and ethnicity. Therefore, the number of applicants from underrepresented groups may actually be slightly, but not significantly, higher.

NUMBER OF APPLICANTS FOR GRADUATE RESEARCH FELLOWSHIPS FROM GROUPS THAT ARE UNDERREPRESENTED IN THE SCIENCE AND ENGINEERING WORKFORCE.

	FY 2002	FY 2003	FY 2004	FY 2005
Goal			increase	increase
Result	730	820	**✓1009**	



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN[8]:
This goal will be continued in FY 2005.

[8] The FY 2005 Performance Plan has now been integrated within the FY 2005 Performance Budget.

Annual Performance Goal 5: Number of applications for Faculty Early Career Development Program (CAREER) awards from investigators at minority-serving institutions.

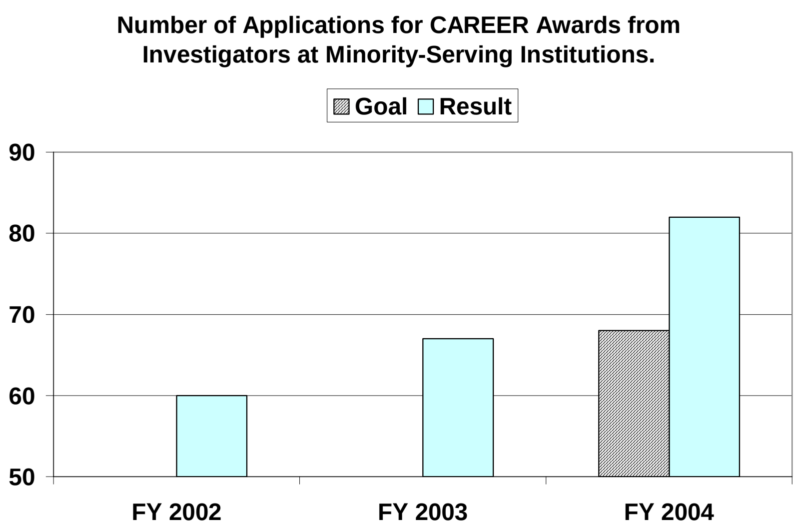
✓ Goal 5 Achieved

The Faculty Early Career Development (CAREER) Program is a Foundation-wide activity that supports junior faculty within the context of their overall career development. It combines in a single program the support of research and education of the highest quality and in the broadest sense. This premier program emphasizes the importance the Foundation places on the early development of academic careers dedicated to stimulating the discovery process in which the excitement of research is enhanced by inspired teaching and enthusiastic learning. Each year NSF selects nominees for Presidential Early Career Awards for Scientists and Engineers (PECASE) from among the first-year awardees supported by the CAREER Program. PECASE awards recognize outstanding scientists and engineers who are in the early stages in their careers, and show exceptional potential for leadership at the frontiers of knowledge.

CAREER is NSF's flagship investment in the development of young faculty, and broadening the institutional base of applicants to the program is a continuing priority. Outreach efforts have specifically focused on attracting faculty from minority-serving institutions and from a broader geographic base.

NUMBER OF APPLICATIONS FOR CAREER AWARDS FROM INVESTIGATORS AT MINORITY-SERVING INSTITUTIONS.

	FY 2002	FY 2003	FY 2004	FY 2005
Goal			increase	increase
Result	60	67	✓**82**	



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN[9]: This goal will be continued in FY 2005.

[9] The FY 2005 Performance Plan has now been integrated within the FY 2005 Performance Budget.

Annual Performance Goal 6: Percent of Nanoscale Science and Engineering (NS&E) proposals with at least one female PI or Co-PI.

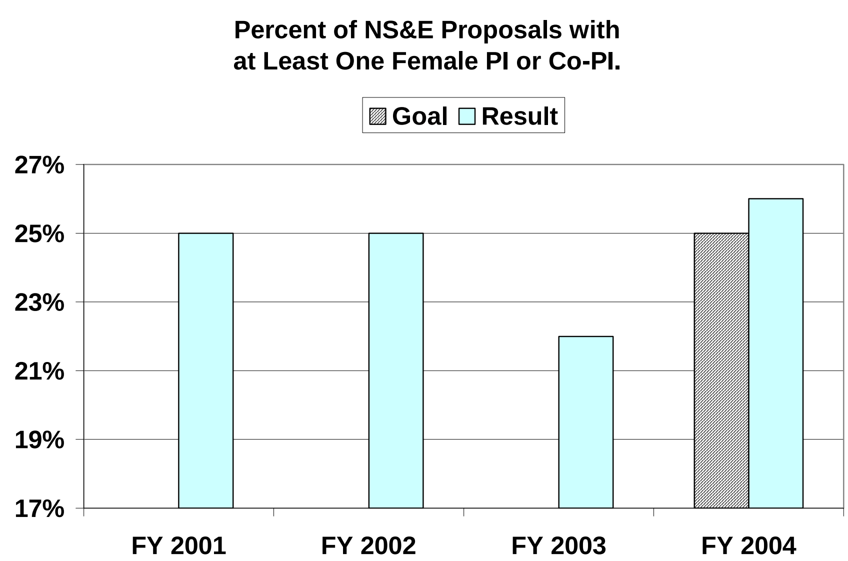
✓Goal 6 Achieved

The Nanoscale Science and Engineering (NS&E) priority area encompasses the systematic organization, manipulation and control of matter at atomic, molecular and supramolecular levels. Novel materials, devices, and systems – with their building blocks on the scale of nanometers – shift and expand possibilities in science, engineering and technology. A nanometer (one-billionth of a meter) is to an inch what an inch is to 400 miles. With the capacity to manipulate matter at this scale, science, engineering and technology are realizing revolutionary advances, in areas such as individualized pharmaceuticals, new drug delivery systems, more resilient materials and fabrics, catalysts for industry and order-of-magnitude faster computer chips.

Nanoscale science and engineering research promises a better understanding of nature, a new world of products beyond what is now possible, high efficiency in manufacturing, sustainable development, better healthcare, and improved human performance. NSF has a continued commitment to increasing participation of female investigators in this priority area.

PERCENT OF NS&E PROPOSALS WITH AT LEAST ONE FEMALE PI OR CO-PI.

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Goal				25%	25%
Result	25%	25%	22%	**✓26%**	



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN[10]: This goal will be continued in FY 2005.

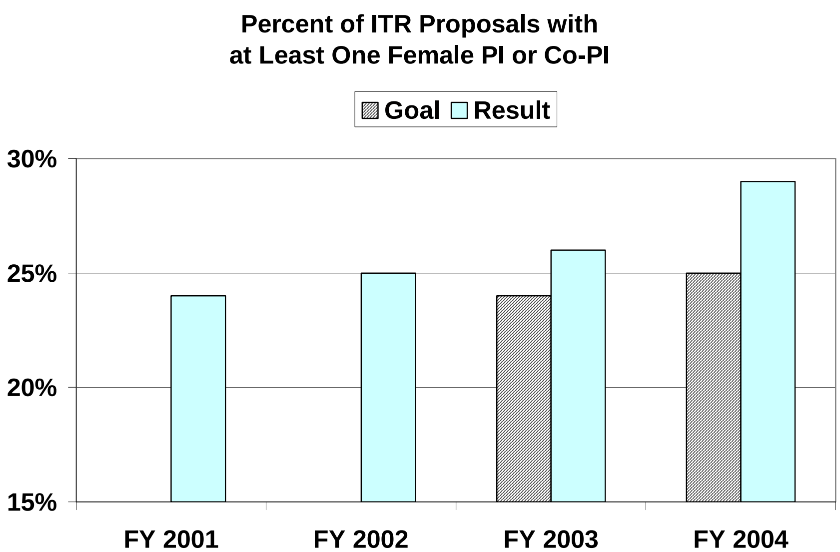
[10] The FY 2005 Performance Plan has now been integrated within the FY 2005 Performance Budget.

Annual Performance Goal 7: Percent of Information Technology Research (ITR) proposals with at least one female PI or Co-PI.

✓ Goal 7 Achieved

Information Technology Research (ITR) has created unprecedented new possibilities for advancing knowledge across the spectrum of human endeavors, including fundamental scientific research, education, engineering design and manufacturing, environmental systems, health care, business, entertainment, and government operations. Information technology is essential in the growth of our economy and in solving critical problems facing our Nation. NSF supports research that extends the frontiers of Information Technology, improves our understanding of Information Technology and its impacts on society, and helps prepare Americans for the Information Age. NSF has a continued commitment to increasing participation of female investigators in this area.

PERCENT OF ITR PROPOSALS WITH AT LEAST ONE FEMALE PI OR CO-PI					
	FY 2001	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**
Goal			24%	25%	
Result	24%	25%	26%	**✓29%**	



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN[11]: ITR is no longer a Foundation-wide priority area as of FY 2005. This goal will not continue in FY 2005.

[11] The FY 2005 Performance Plan has now been integrated within the FY 2005 Performance Budget.

Annual Performance Goal 8: Percent of Nanoscale Science and Engineering (NS&E) proposals with at least one minority principal investigator (PI) or co-principal investigator (Co-PI).

✖ Goal 8 Not Achieved

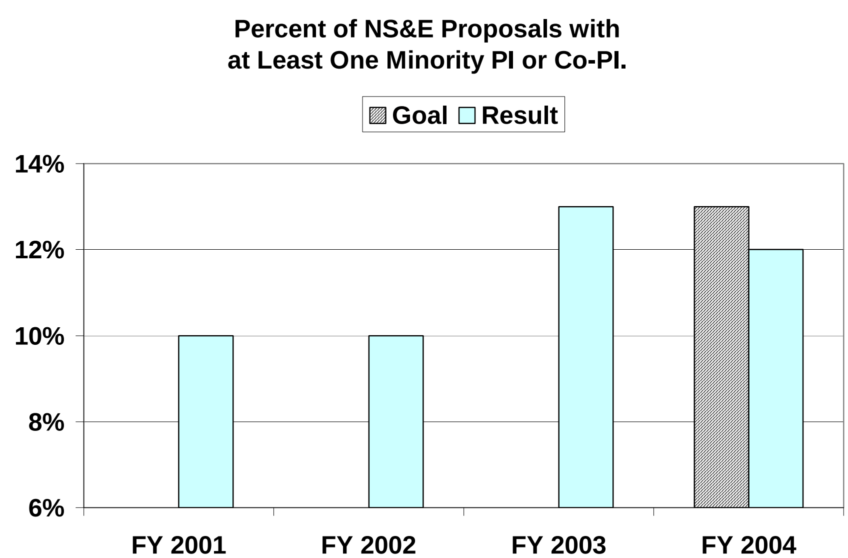
The Nanoscale Science and Engineering (NS&E) priority area encompasses the systematic organization, manipulation and control of matter at atomic, molecular and supramolecular levels. Novel materials, devices, and systems – with their building blocks on the scale of nanometers – shift and expand possibilities in science, engineering and technology. A nanometer (one-billionth of a meter) is to an inch what an inch is to 400 miles. With the capacity to manipulate matter at this scale, science, engineering and technology are realizing revolutionary advances, in areas such as individualized pharmaceuticals, new drug delivery systems, more resilient materials and fabrics, catalysts for industry and order-of-magnitude faster computer chips.

Nanoscale science and engineering research promises a better understanding of nature, a new world of products beyond what it is now possible, high efficiency in manufacturing, sustainable development, better healthcare and improved human performance. NSF has a continued commitment to increasing participation of investigators from underrepresented minority groups in this priority area.

PERCENT OF NS&E PROPOSALS WITH AT LEAST ONE MINORITY PI OR CO-PI.

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Goal				13%	13%
Result	10%	10%	13%	**✖12%**	

WHY WE DID NOT ACHIEVE THIS GOAL: NSF is committed to its goal of increasing participation by minorities. It is not evident why there was a decrease in applications from minority investigators this year.



STEPS WE WILL TAKE TO ACHIEVE THIS GOAL: We will continue our efforts to encourage minorities to submit proposals to these areas.

IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN[12]: This goal will be continued in FY 2005.

[12] The FY 2005 Performance Plan has now been integrated within the FY 2005 Performance Budget.

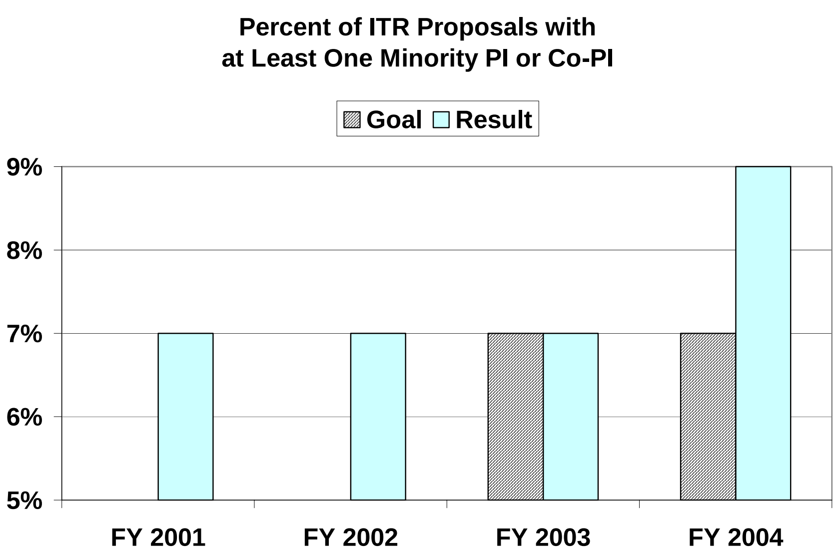
Annual Performance Goal 9: Percent of Information Technology Research (ITR) proposals with at least one minority PI or Co-PI.

✓ Goal 9 Achieved

Information Technology Research (ITR) has created unprecedented new possibilities for advancing knowledge across the spectrum of human endeavors, including fundamental scientific research, education, engineering design and manufacturing, environmental systems, health care, business, entertainment, and government operations. Information technology is essential in the growth of our economy and in solving critical problems facing our nation. NSF supports research that extends the frontiers of Information Technology, improves our understanding of Information Technology and its impacts on society, and helps prepare Americans for the Information Age. NSF has a continued commitment to increasing participation of investigators from underrepresented minority groups in this area.

PERCENT OF ITR PROPOSALS WITH AT LEAST ONE MINORITY PI OR CO-PI

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Goal			7%	7%	
Result	7%	7%	7%	**✓9%**	



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN[13]: ITR is no longer a Foundation-wide priority area as of FY 2005. This goal will not continue in FY 2005.

[13] The FY 2005 Performance Plan has now been integrated within the FY 2005 Performance Budget.

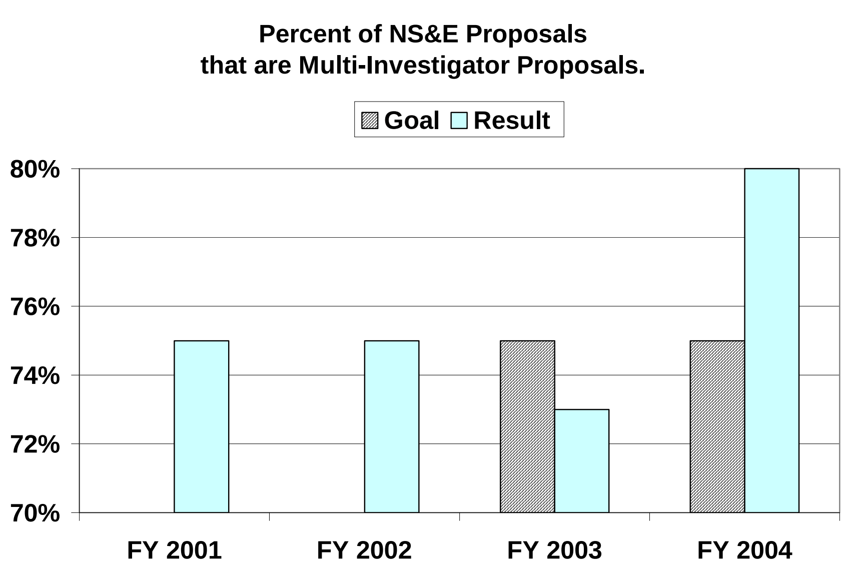
Annual Performance Goal 10: Percent of Nanoscale Science and Engineering (NS&E) proposals that are multi-investigator proposals.

✓ Goal 10 Achieved

The Nanoscale Science and Engineering (NS&E) priority area encompasses the systematic organization, manipulation and control of matter at atomic, molecular and supramolecular levels. Novel materials, devices, and systems – with their building blocks on the scale of nanometers – shift and expand possibilities in science, engineering and technology. A nanometer (one-billionth of a meter) is to an inch what an inch is to 400 miles. With the capacity to manipulate matter at this scale, science, engineering and technology are realizing revolutionary advances, in areas such as individualized pharmaceuticals, new drug delivery systems, more resilient materials and fabrics, catalysts for industry and order-of-magnitude faster computer chips.

Nanoscale science and engineering research promises a better understanding of nature, a new world of products beyond what it is now possible, high efficiency in manufacturing, sustainable development, better healthcare and improved human performance. The NSF NS&E priority area strives to foster collaborations among investigators that may not have otherwise occurred.

PERCENT OF NS&E PROPOSALS THAT ARE MULTI-INVESTIGATOR PROPOSALS.					
	FY 2001	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**
Goal			75%	75%	75%
Result	75%	75%	73%	**✓80%**	



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN[14]: This goal will be continued in FY 2005.

[14] The FY 2005 Performance Plan has now been integrated within the FY 2005 Performance Budget.

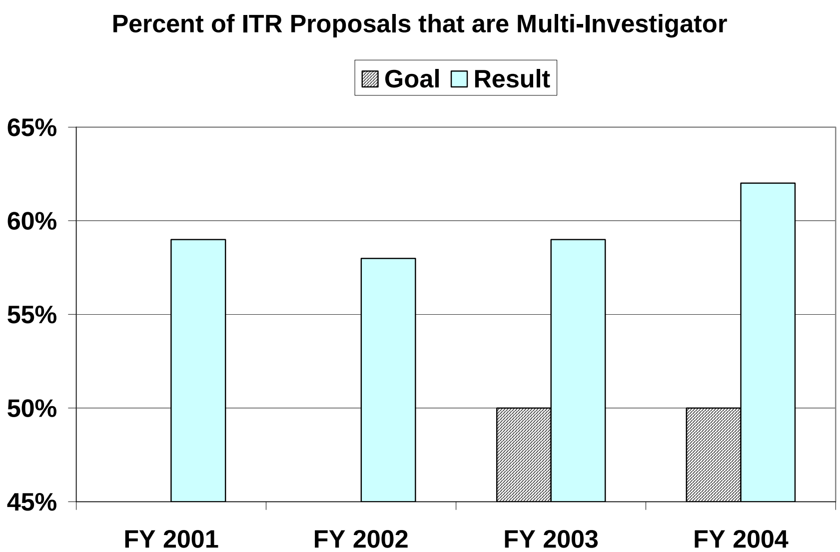
Annual Performance Goal 11: Percent of Information Technology Research (ITR) proposals that are multi-investigator.

✓ Goal 11 Achieved

Information Technology Research (ITR) has created unprecedented new possibilities for advancing knowledge across the spectrum of human endeavors, including fundamental scientific research, education, engineering design and manufacturing, environmental systems, health care, business, entertainment, and government operations. Information technology is essential in the growth of our economy and in solving critical problems facing our Nation. NSF supports research that extends the frontiers of Information Technology, improves our understanding of Information Technology and its impacts on society, and helps prepare Americans for the Information Age. The NSF ITR priority area strives to foster collaborations among investigators that may not have otherwise occurred.

PERCENT OF ITR PROPOSALS THAT ARE MULTI-INVESTIGATOR

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Goal			50%	50%	
Result	59%	58%	59%	**✓62%**	



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN[15]: ITR is no longer a Foundation-wide priority area as of FY 2005. This goal will not continue in FY 2005.

[15] The FY 2005 Performance Plan has now been integrated within the FY 2005 Performance Budget.

Annual Performance Goal 12: Successful development of workforce, as qualitatively evaluated by external experts for Nanoscale Science and Engineering (NS&E).

✓ Goal 12 Achieved

The following is taken from the Nanoscale Science and Engineering Committee of Visitors report dated 07/30/2004 Question[16] D.7, page 33. After reporting to its parent Advisory Committee (Engineering), the report will be available at www.nsf.gov/od/gpra/COV/start.htm.

"The developments are on track for this longer term goal. The NS&E program has been pivotal in developing a skilled workforce and a public that is informed about nanoscience and engineering. The number of scientists working in this area and the amazing web of interdisciplinary connections established are some of the best outcomes to-date. The skilled workforce and the web of interactions are critical for maintaining U.S. leadership in this area. The outcomes are on track for development of a skilled nanotechnology workforce and an informed public on nanoscale science and engineering.

The entire NUE program is designed to promote the successful development of a skilled workforce and a public that is informed about nanoscience and nanotechnology. A particularly good example of workforce development is the (Award #0302163) Pennsylvania State University, University Park program whose goal is to develop a well-educated, technician level nanotechnology workforce. This is accomplished by offering Penn State and area community college students a six-module capstone semester at the Penn State Nanofabrication Facility. In addition, this same Penn State NUE project offers summer "nano camps" for middle school and high school students from across Pennsylvania, contributing to a more scientifically informed public.

In some cases, industry has partnered with educators to train students. An excellent example of such a partnership was between Siena College and Evident Technologies, Inc. (award #0303992). Evident Technologies, a nanotechnology manufacturing and application firm, provided internships for undergraduates. Evident Technologies also provided expert staff members to team-teach a nanotechnology course at Siena College."

IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN: The next scheduled evaluation of this program is FY 2007. The goal will not appear in FY 2005.

[16] D.7 Have the awards promoted the successful development of a skilled workforce and a public that is informed about nanoscience and nanoengineering? (NIRTs and NSECs)

NSF STRATEGIC OUTCOME GOALS

B. IDEAS

IDEAS STRATEGIC OUTCOME GOAL: Discovery across the frontier of science and engineering, connected to learning, innovation and service to society.

✓ Goal 13 Achieved

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

Annual Performance Goal 13: NSF's performance is successful when, *in the aggregate*, results reported in the period FY 2004 demonstrate significant achievement in the majority of the following indicators:

- Enable people who work at the forefront of discovery to make important and significant contributions to science and engineering knowledge.
- Encourage collaborative research and education efforts – across organizations, disciplines, sectors and international boundaries.
- Foster connections between discoveries and their use in the service of society.
- Increase opportunities for underrepresented individuals and institutions to conduct high quality, competitive research and education activities.

- Provide leadership in identifying and developing new research and education opportunities within and across S&E fields.
- Accelerate progress in selected S&E areas of high priority by creating new integrative and cross-disciplinary knowledge and tools, and by providing people with new skills and perspectives.

RESULT: NSF achieved this goal. External experts provided examples of significant achievement during FY 2004 reporting. Comments by the AC/GPA and examples they selected are presented for each of the performance indicators and areas of emphasis for this goal.

IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN: This goal will be continued in FY 2005.

IDEAS: Comments by the Advisory Committee for GPRA Performance Assessment

The following statements concerning NSF achievement with respect to the indicators for the IDEAS goal are excerpted from the AC/GPA Report on NSF's IDEAS portfolio. Additional comments as well as examples in support of significant achievement for each indicator are available at *http://www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf04216*.

"The Committee concluded that there is significant achievement in all indicators of the IDEAS strategic outcome goal, which is to foster "discovery across the frontier of science and engineering, connected to learning, innovation, and service to society." The Committee concluded that NSF had met the goal for each indicator in making investments in discovery, collaborative research and education, connections between discoveries and their use in society, increased opportunities for underrepresented individuals and institutions, developing new research and education opportunities, and creating new integrative and cross-disciplinary knowledge and tools.

Quality: We were asked to comment on how NSF ***allocates*** funds to ensure quality in its research portfolio. We wondered why this 'allocation' quality perspective was chosen versus a more generic quality perspective. NSF might reconsider how this question is asked. From the allocation perspective, one can examine whether overall award size is too small to carry out meaningful research or whether the allocation process is optimal when one NSF program can fund research rated fair and another program only has enough funds to support proposals that are rated excellent. NSF might track how deep into the rating levels a particular program, division, or directorate goes to explore whether NSF needs to "rebalance" its funding portfolio to ensure that the highest rated proposals across the NSF get funded. In some respects, this imbalance could be due to the artificial division of funding stemming from NSF's organization.

The Committees of Visitors looked at several issues that may or may not be related to this "allocation" quality perspective. One was whether there is enough participation of underrepresented groups or geographically distributed institutions to ensure that the NSF gets the broadest engagement of intellectual capacity offered in the nation's academic sector. For example, one COV review noted that non-minority PIs were almost twice as likely to be funded as minority PIs. In addition, the COV believed that the quality of proposals could be substantially improved through the increased involvement of NSF program managers in guiding proposal development. Declining numbers of or increasingly burdened program managers could jeopardize the system of feedback that improves the quality of proposals (see discussion of merit review in the Organizational Excellence chapter). In general, the very existence of the merit review process is a major element in ensuring that NSF funds the highest quality proposals. The allocation issues mentioned above are ones that should be examined in order to further optimize the system.

From the Committee's review of the available COV reports, there may be evidence of inequitable resource allocation among directorates. For example, the EHR Teacher Enhancement COV stated, 'Although proposals were generally of high quality, six of the 27 proposals funded seemed to be of lower quality. And there was little documentation in the jackets for justifications, based on needs, geography, innovation, or other considerations.' Conversely, in one CISE division, the COV reported that although the program continues to fund proposals of high quality, funds are inadequate to support all of the high quality proposals – a comment NOT unique to the CISE Directorate. However, the COV further stated, 'A particularly disturbing trend is the increasing gap between the appropriateness and actual size of the awards: while the allocation is fair given the available levels, the amounts are so inadequate as to verge on irrelevance.'

Relevance: We were also asked to comment on *why* an NSF R&D investment is important, relevant, and appropriate. Relevance is a function of national priorities, agency mission, specific field of science or engineering, and customer needs. It was not entirely clear how NSF ties its goals and programs to national needs. It may do that, but we did not see how that happens in our short time together. Having said that, however, we are not suggesting that NSF relate every dollar it awards to some specific (and perhaps transitory) national need, e.g., homeland security, or energy independence, or transportation infrastructure (the list is endless). This was last tried in the 1970s in the Research Applied to National Needs program, which was, with a few notable exceptions, not particularly successful. We are, however, suggesting that NSF might consider describing more fully the relevance or impact of its entire portfolio for future AC/GPA committees beyond its current articulated goal to fund broad and basic research. Clearly, most of these investments advance knowledge and train the next generation of scientists and engineers. That is clearly relevant to our nation and clearly consistent with NSF's mission.

High Risk: We were asked to look at nuggets that were high risk, innovative, or multidisciplinary. In general, we saw few proposals that we would consider high risk although we did not have a definition of what high risk really means. To many of us, it would be like building a cutting edge satellite observing system or some other technology that had never been done before with the understanding that there was a reasonable chance that it might fail. We believe the merit review process actually filters out these type of high risk projects and they are likely only to be funded when a NSF program manager takes the bold steps to support one of these efforts despite reviews that might be unfavorable (i.e., because of the somewhat conservative nature of the merit review process). There were a few proposals that did fall into what we considered the high risk category.

Multidisciplinary Research: Efforts to fund multidisciplinary projects appear uneven across programs. For example, the COV report on the MPS Office of Multidisciplinary Activities (OMA) raises concerns about the relative level of participation in this Office by the various MPS divisions. The COV found that OMA has been effective in the Astronomy, Chemistry, and Physics Divisions, but that both the Mathematics Division and the Materials Research Division are less dependent on OMA because each has its own interdisciplinary programs. Within the Social, Behavioral and Economic Sciences (SBE) Directorate, there are several programs that are inherently multidisciplinary, but at least one COV report expressed concern that interdisciplinary initiatives were diluting support for core disciplines. The Economics, Decision and Management Sciences Cluster COV report observes that, 'evidence exists that large and multidisciplinary efforts have been successful in the natural and physical sciences and in engineering, but is not obvious that similar success in the social sciences and economics is likely.' The COV expressed concern that 'attempts to integrate science across even broader disciplinary boundaries can result in dilution of funding and programmatic energies without sufficiently concentrated support for success.'

Funding of multidisciplinary, collaborative research appears to fall into three categories: (i) projects that bring together scientists from different disciplines around a specific theme; (ii) projects that fund scientists from within a single discipline to conduct research that is interdisciplinary; and (iii) projects that fund collaborative research among scientists from different disciplines.

The unevenness in the support for multidisciplinary research across programs could reflect variations across disciplines in the extent to which disciplinary boundaries are blurred. There is also some indication that there are problems for programs that are not inherently interdisciplinary in reviewing interdisciplinary proposals. Finally, because of funding constraints, especially in directorates with smaller budgets, there is a tension between funding research in core disciplines and funding multidisciplinary activities. This tension is not new, but as disciplines naturally evolve, such strains will need to be thoughtfully managed so as to continue to encourage and support the key stakeholders in the scientific communities.

The Committee was impressed at the overall number, breadth, and depth of the accomplishments (nuggets) available for review. Accomplishments were selected that best represented each of the six indicators."

INDICATOR 1: Enable people who work at the forefront of discovery to make important and significant contributions to science and engineering knowledge.

RESULT: *Demonstrated significant achievement.*

"Results reported in 2004 indicate that awards made in each of the directorates have enabled people to work at the forefront of discovery and to make important and significant contributions to science and engineering, and in many cases to enable these individuals, or others, to transform these ideas/results into "products" that benefit humankind."

INDICATOR 2: Encourage collaborative research and education efforts – across organizations, disciplines, sectors and international boundaries.

RESULT: *Demonstrated significant achievement.*

"NSF has supported several projects that encourage collaborative research and education efforts across organizations, disciplines, sectors and international boundaries. Several programs are inherently interdisciplinary -- for example, within the Social, Behavioral and Economic Sciences (SBE) Directorate, the Decision, Risk and Management Science program; Innovation and Organizational Change program; the Law and Social Science program; the Methodology, Measurement and Statistics program; the Science and Technology Studies Program; and the Societal Dimensions of Engineering, Science and Technology Program sponsor research that crosses traditional disciplinary boundaries. The COV report on the LSS programs describes the cross-fertilization process that results from this funding:

> "LSS studies often offer new perspectives on established disciplinary scholarship by importing existing theories into the study of law and testing these theories in the legal arena. In other instances, core social processes can be studied especially well in the legal arena and theoretical innovations can then be exported to the main social science disciplines. As an example of this latter pattern, we point to research on regulation and institutionalization. LSS-funded empirical studies of institutionalization are every bit as important to the development of institutional theory in sociology and political science as they are the understanding of legal processes." (LSS COV Report, March 2003, p. 19).

These programs have also been important as a source of expertise within NSF in the review of cross-disciplinary proposals. (IOC COV report, March 2004, p. 7)."

INDICATOR 3: Foster connections between discoveries and their use in the service of society.

RESULT: ***Demonstrated significant achievement.***

"NSF funds a broad range of proposals that foster connections between discoveries and their use in the service of society. "

INDICATOR 4: Increase opportunities for underrepresented individuals and institutions to conduct high quality, competitive research and education activities.

RESULT: ***Demonstrated significant achievement.***

"Projects and accomplishments under this indicator are impressive and contribute significantly toward the attainment of the overall IDEAS strategic outcome goal. The accomplishments described below represent novel programs that engage underrepresented individuals and institutions in the sciences in general as well as in high quality research activities."

INDICATOR 5: Provide leadership in identifying and developing new research and education opportunities within and across S&E fields.

RESULT: ***Demonstrated significant achievement.***

"NSF funding has developed new areas of scientific inquiry, new applications of scientific knowledge, and innovative programs that integrate research and STEM education."

INDICATOR 6: Accelerate progress in selected S&E areas of high priority by creating new integrative and cross-disciplinary knowledge and tools, and by providing people with new skills and perspectives.

RESULT: ***Demonstrated significant achievement.***

"NSF has funded several proposals that support this indictor. The underlying theme of these examples is the creation of new knowledge and skill sets by learning differently together."

Annual Performance Goal 14: Qualitative assessment by external experts that program is responsible for a broad-based and capable interdisciplinary research community that advances fundamental nanotechnology knowledge, with impact on other disciplinary fields.

✓ Goal 14 Achieved

The following is taken from the Nanoscale Science and Engineering Committee of Visitors report dated 07/30/2004 Question D.6[17], page 33. After reporting to its parent Advisory Committee (Engineering), the report will be available a www.nsf.gov/od/gpra/COV/start.htm.

"The developments are on track for this longer term goal. One of the most significant outcomes of the NS&E investment has been the development of a broad-based and capable interdisciplinary research community. COV members termed this contribution "off scale" and used words like "outstanding performance." The program structure that Mike Roco has instituted truly fosters and encourages interdisciplinary participation and is very effective in developing an interdisciplinary research community.

NSF has done an exceptional job in building nanoscience, a nanoscience community, and the tradition of interdisciplinary collaboration. The NS&E program should be praised for setting the standard in this regard. There is no question that the strong interdisciplinary research community that has been fostered by the NSE will be contributing to the next generation of work force who will be extremely well equipped for our nation's next generation of industrial needs.

The existence of this community is evidence by the large number of meetings that service the community and the journals that are emerging to capture the advances. Examples of new journals include the American Chemical Society's *Nano Letters* and *Small*."

IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN: The next scheduled evaluation of this program is FY 2007. The goal will not appear in FY 2005.

[17] D.6 Has NS&E been responsible for developing a broad-based and capable interdisciplinary research community that advances fundamental nanoscience and engineering knowledge, with impact on other disciplinary fields? (All modes and themes)

Annual Performance Goal 15: As qualitatively evaluated by external experts, the successful development of a knowledge base for systematic control of matter at the nanoscale level that will enable the next industrial revolution for the benefit of society.

✓ Goal 15 Achieved

The following is taken from the draft version of the Nanoscale Science and Engineering Committee of Visitors report dated 07/30/2004 Question D.3[18], page 29. After reporting to its parent Advisory Committee (Engineering), the report will be available a www.nsf.gov/od/gpra/COV/start.htm. The numbers in parenthesis are NSF award numbers.

"The ability to systematically control matter at the nanoscale has been a great success story. The developments are on track for this longer term goal. Nanoparticle synthesis strategies that didn't exist five to ten years ago now allow us to control size and composition and shape with precision and infinite variability." For example:

- Semiconductor Quantum Dots - We can control size and optical properties of semiconductor nanoparticles at will. These particles are made by simple chemical synthesis methods. The applications of quantum dots in bio-sensing are rapidly developing. Example: UC Davis (0210807)
- Carbon Nanotubes – These are now commercially available. Example: Smalley at Rice University (NSEC 0118007).
- Metal Nanoparticles – Colloidal metal nanoparticles have been studied since Faraday. However, these particles were almost always spherical. In recent years we have learned to control metal nanoparticles shape, making nanorods and nanoprisms. These have many applications, for example in surface-enhanced Raman spectroscopy, that are progressing. Example: Penn State (0210229)
- Organic Nanoparticles - There are many examples here, including *dendrimer chemistry*, which allows us to control size and chemistry of organic nanoparticles with amazing precision and great variability. Applications to drug delivery are being developed. Examples: Crommie at UC Berkeley (0210176), Karen Wooley at Washington University (0210247).

New fabrication techniques are being developed, including nanolithography and chemical vapor deposition techniques. For example, new chemical vapor deposition (CVD) growth techniques of carbon nanotubes holds great promises for the development of integrated nanoscale systems (NSF Award 0102995). NSF is supporting the developments of new nanoscale fabrication techniques; such as deposition by ultrafast laser-assisted scanning probe techniques (NSF Award 0103390).

Furthermore, the area of molecular electronics is where a tremendous amount of work is beginning to produce some fundamental understanding for the phenomena and how these phenomena may be exploited for sensors, for ultra high density memory, *etc*. Areas include new magnetic phenomena, which can generate new memory concepts. We are learning a tremendous amount about the creation of nanoscale particulate materials including needles, pyramids, and other novel shapes and about the electrical, chemical, and mechanical properties of these materials and composites made from these materials.

[18] D.3 Has there been successful development of a knowledge base for systematic control of matter at the nanoscale that will enable the next industrial revolution for the benefit of society?

The important question is: Will these developments enable the next industrial revolution? We now need to move into areas that will bridge the gap between fundamental understanding and industrial processes, and here the future is less certain. For example, the ability to assemble, measure, and model lags significantly behind the repertoire of experimental methods available to make nanoparticles. As an example: we have perhaps 50 ways to make a small amount of drug nanoparticles, perhaps three ways to make large (manufacturing scale) amounts, and almost no knowledge regarding how to incorporate drug nanoparticles into practical products, and minimal knowledge in how to test for safety and comparative efficacy of products containing drug nanoparticles.

Despite the remarkable progress cited above, we have a long way to go. The need to “systematically” control matter and enable the next generation of industry may require a more focused and strategic investment than is appropriate for the NSF. While this topic lies outside the purview of the COV, we urge NSF to couple with other mission agency investments in NNI to ensure that fundamental knowledge is transferred and appropriately developed to ensure broader societal impact.

Implications for the FY 2005 Performance Plan: The next scheduled evaluation of this program is FY 2007. The goal will not appear in FY 2005.

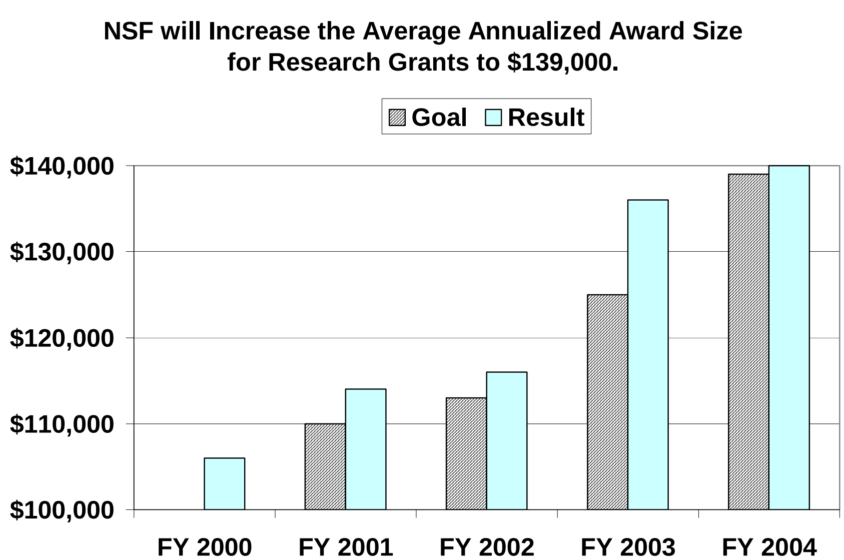
Annual Performance Goal 16: NSF will increase the average annualized award size for research grants to $139,000.

✓ Goal 16 Achieved

NSF is continuing its goal of increasing award size[19]. Our long-term goal is to reach an average annualized award size of $250,000.

Adequate award size is important both for attracting high-quality proposals and for ensuring that proposed work can be accomplished as planned. Larger awards increase the efficiency of the system by allowing scientists and engineers to devote a greater portion of their time to actual research rather than to proposal writing and other administrative work.

NSF will increase the AVERAGE ANNUALIZED AWARD SIZE FOR RESEARCH GRANTS to $139,000.						
	FY 2000	**FY 2001**	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**
Goal		$110,000	$113,000	$125,000	$139,000	$142,000
Result	$106,000	$114,000	$116,000	$136,000[20]	**✓$140,000**	



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN: The average annualized award size will be increased to $142,000 for FY 2005.

[19] The award size and duration performance goals are applicable only to competitive research grants (a subset of awards that focuses on awards to individual investigators and small groups).
[20] In FY 2003 collaborative proposals submitted as individual proposals from the collaborating institutions were counted as a single proposal as NSF treats them as a single proposal for review and award/decline decisions. If such collaborative proposals are counted individually, the average annualized award size for FY 2003 is $121,380.

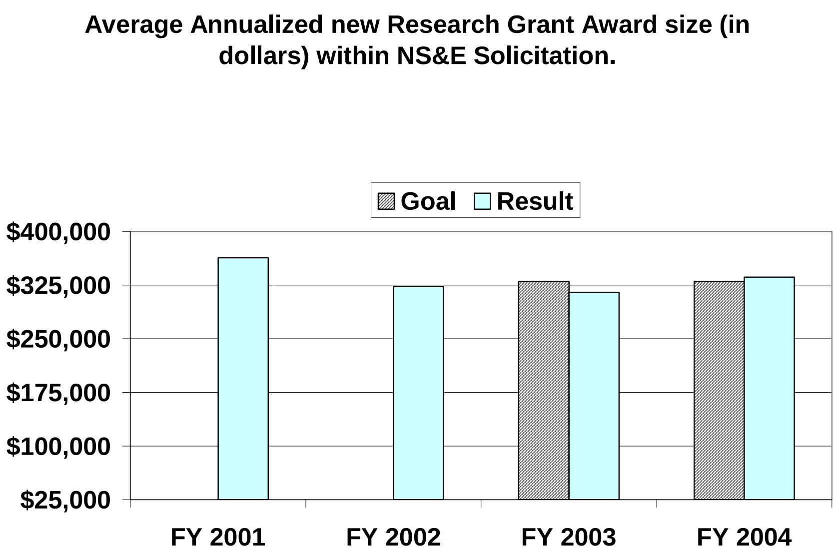
Annual Performance Goal 17: Average annualized new research grant award size for Nanoscale Interdisciplinary Research within the Nanoscale Science and Engineering (NS&E) solicitation.

✓ Goal 17 Achieved

Larger award sizes allow the research community to spend more time conducting research, and less time preparing multiple proposals to accomplish a research goal. An average annualized award size of $330,000 for Nanoscale Interdisciplinary Research Teams (to which this goal applies) is an ambitious target; significantly greater than NSF's current average annualized award size goal of $139,000, and even larger than NSF's long-term goal of $250,000.

AVERAGE ANNUALIZED NEW RESEARCH GRANT AWARD SIZE WITHIN NS&E SOLICITATION.

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Goal			$330,000	$330,000	
Result	$363,000	$323,000	$315,000	**✓$336,000**	



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN[21]: NSF is replacing, in FY 2005, PART program award size and duration efficiency goals with goals that combine merit review quality and the time it takes to process proposals. Therefore, this goal will not be continued as a PART goal.

[21] The FY 2005 Performance Plan has now been integrated within the FY 2005 Performance Budget.

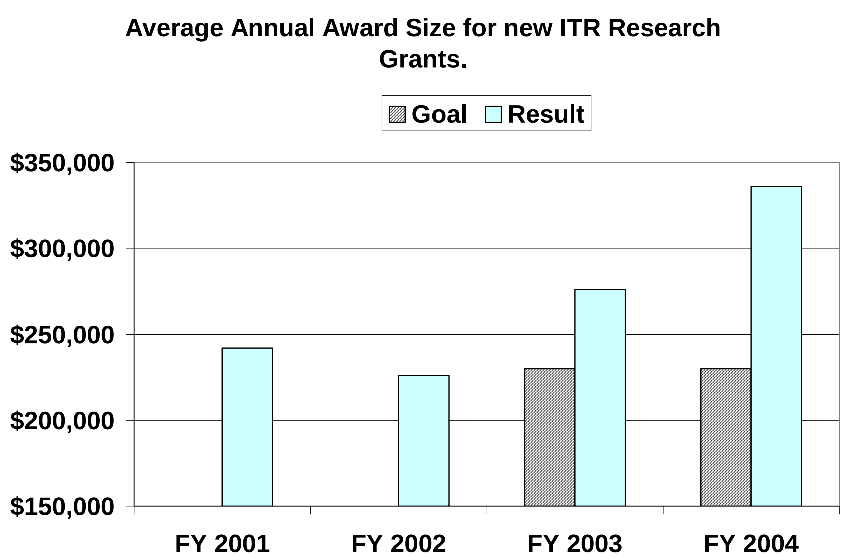
Annual Performance Goal 18: Average annual award size for new Information Technology Research (ITR) research grants.

✓ Goal 18 Achieved

Larger award sizes allow the research community to spend more time conducting research, and less time preparing multiple proposals to accomplish a research goal. An average annualized award size of $230,000 is an ambitious target for this priority area; significantly greater than NSF's current average annualized award size of $140,000.

AVERAGE ANNUAL AWARD SIZE FOR NEW ITR RESEARCH GRANTS.

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Goal			$230,000	$230,000	
Result	$242,000	$226,000	$276,000	✓**$336,000**	



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN[22]: ITR is no longer a Foundation-wide priority area as of FY 2005. This goal will not continue in FY 2005.

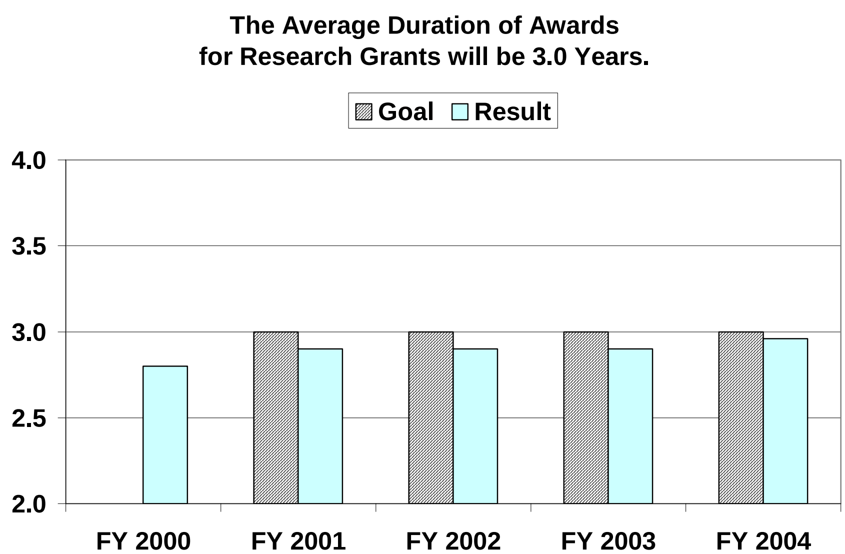
[22] The FY 2005 Performance Plan has now been integrated within the FY 2005 Performance Budget.

Annual Performance Goal 19: The average duration of awards for research grants will be 3.0 years.

✖ Goal 19 Not Achieved

Our long-term goal is to reach an average award duration of 5 years[23].

The AVERAGE duration of Awards for Research Grants.						
	FY 2000	**FY 2001**	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**
Goal	N/A	3.0 years	3.0 years	3.0 years	3.0 years	3.0 years
Result	2.8 years	2.9 years	2.9 years	2.9 years	**✖2.96 years**	



WHY WE DID NOT ACHIEVE THIS GOAL: NSF is committed for FY 2005 to its long-term goal of increasing award duration to 5 years. Progress on this goal is budget dependent.

STEPS WE WILL TAKE TO ACHIEVE THIS GOAL: Program Directors must balance competing requirements: increasing award size, increasing duration of awards, and success rates. NSF will continue to focus in FY 2005 on increasing award size and duration. However, due to decreasing success rate for our investigators, this goal is being re-evaluated.

IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN: This goal will be maintained but re-evaluated in FY 2005.

[23] The award size and duration performance goals are applicable only to competitive research grants (a subset of awards that focuses on awards to individual investigators and small groups).

Annual Performance Goal 20: Average award duration of new Information Technology Research (ITR) research grants.

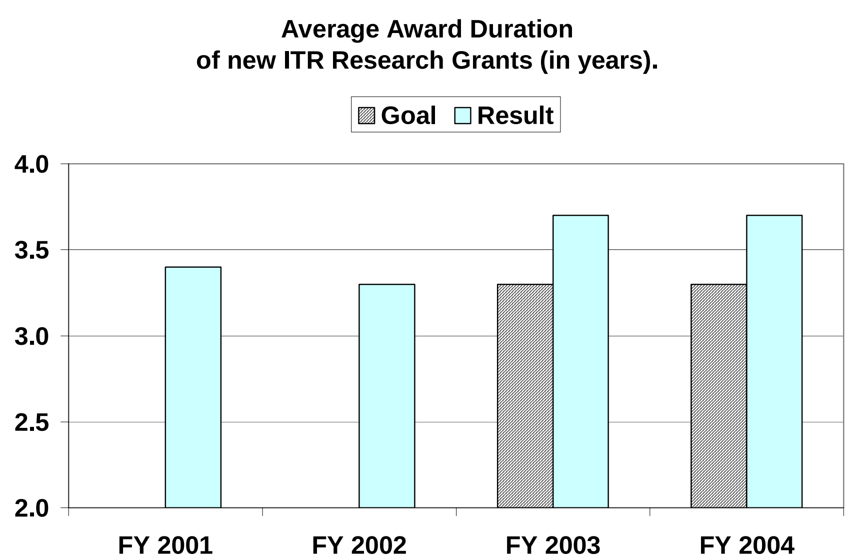
✓ Goal 20 Achieved

Information Technology Research (ITR) has created unprecedented new possibilities for advancing knowledge across the spectrum of human endeavors, including fundamental scientific research, education, engineering design and manufacturing, environmental systems, health care, business, entertainment, and government operations. Information technology is essential in the growth of our economy and in solving critical problems facing our nation. NSF supports research that extends the frontiers of Information Technology, improves our understanding of Information Technology and its impacts on society, and helps prepare Americans for the Information Age.

Longer award durations allow the research community to spend more time conducting research, and less time preparing proposals to continue funding ongoing projects.

AVERAGE AWARD DURATION OF NEW ITR RESEARCH GRANTS (IN YEARS).

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Goal			3.3 years	3.3 years	
Result	3.4 years	3.3 years	3.7 years	✓**3.7 years**	



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN[24]: ITR is no longer a Foundation-wide priority area as of FY 2005. This goal will not continue in FY 2005.

[24] The FY 2005 Performance Plan has now been integrated within the FY 2005 Performance Budget.

Annual Performance Goal 21: Average duration of new research grant awards for Nanoscale Interdisciplinary Research within the Nanoscale Science and Engineering solicitation.

✓ Goal 21 Achieved

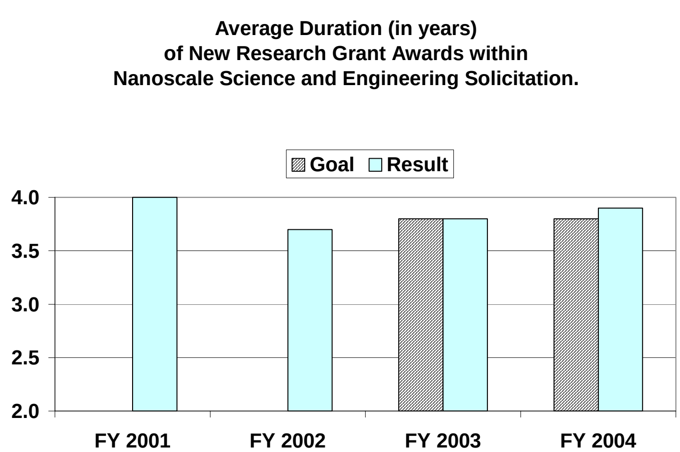
The Nanoscale Science and Engineering (NS&E) priority area encompasses the systematic organization, manipulation and control of matter at atomic, molecular and supramolecular levels. Novel materials, devices, and systems – with their building blocks on the scale of nanometers – shift and expand possibilities in science, engineering and technology. A nanometer (one-billionth of a meter) is to an inch what an inch is to 400 miles. With the capacity to manipulate matter at this scale, science, engineering and technology are realizing revolutionary advances, in areas such as individualized pharmaceuticals, new drug delivery systems, more resilient materials and fabrics, catalysts for industry and order-of-magnitude faster computer chips.

Nanoscale science and engineering research promises a better understanding of nature, a new world of products beyond what it is now possible, high efficiency in manufacturing, sustainable development, better healthcare and improved human performance.

Longer award durations allow the research community to spend more time conducting research, and less time preparing proposals to continue funding ongoing projects. An average award duration of 3.8 years for Nanoscale Interdisciplinary Research Teams is an ambitious target; significantly greater than NSF's current average duration of 3.0 years.

AVERAGE DURATION (IN YEARS) OF NEW RESEARCH GRANT AWARDS WITHIN NANOSCALE SCIENCE AND ENGINEERING SOLICITATION.

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Goal			3.8 years	3.8 years	
Result	4 years	3.7 years	3.8 years	**✓3.9 years**	

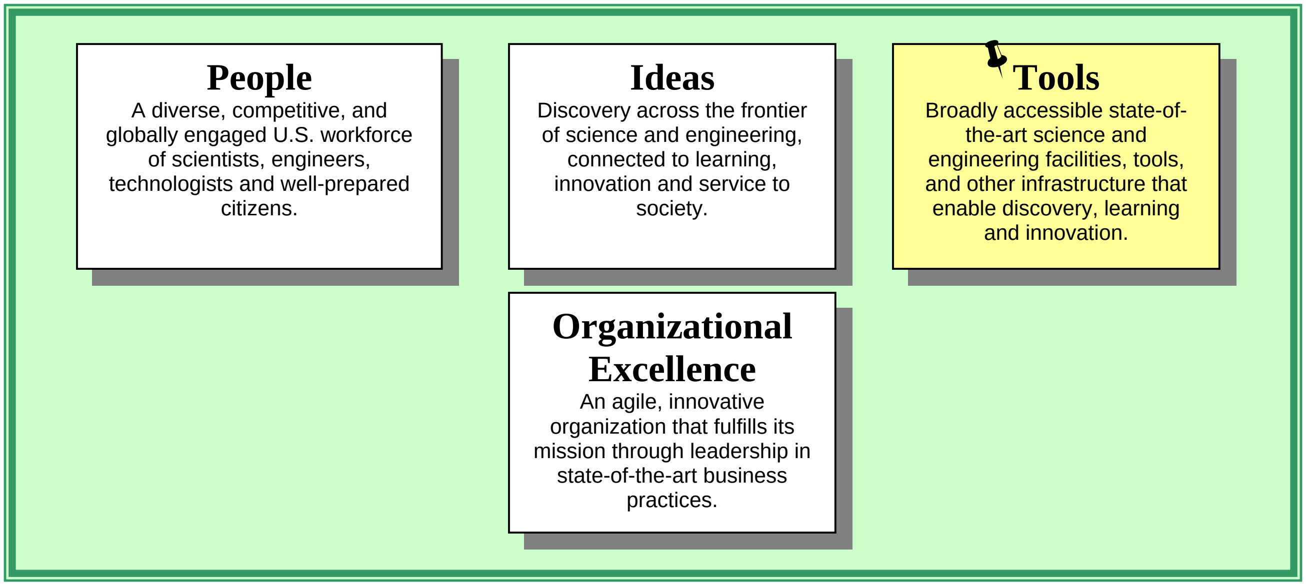


IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN[25]: NSF is replacing, in FY 2005, PART program award size and duration efficiency goals with goals that combine merit review quality and the time it takes to process proposals. Therefore, this goal will not be continued as a PART goal.

[25] The FY 2005 Performance Plan has now been integrated within the FY 2005 Performance Budget.

NSF STRATEGIC OUTCOME GOALS

C. TOOLS



TOOLS STRATEGIC OUTCOME GOAL: Broadly accessible state-of-the-art S&E facilities, tools, and other infrastructure that enable discovery, learning and innovation.

✓ Goal 22 Achieved

As the issues researchers face increasingly involve phenomena at or beyond the limits of our measurement capabilities, their study requires the use of new generations of powerful tools. Examples of such tools include instrumentation and equipment needed by individual investigators in the conduct of their research, multi-user facilities, digital libraries, accelerators, telescopes, research vessels, and aircraft and earthquake simulators. In addition, funding devoted to the TOOLS strategic outcome area provides resources needed to support large surveys and databases as well as computational and computing infrastructures for all fields of science, engineering, and education.

NSF provides support for large multi-user facilities that meet the need for state-of-the-art, world-class research platforms vital to new discoveries and the progress of research. NSF support may include construction, upgrades, operations, maintenance, and personnel needed to assist scientists and engineers in the conduct of research at such facilities. NSF consults with other agencies and international partners to avoid duplication and optimize capabilities for American researchers.

All of these investments enable the Foundation to meet its mission of promoting the progress of science, while responding specifically to direction in the NSF Act of 1950 to foster and support the development and use of computer and other scientific and engineering methods and technologies, primarily for research and education in the sciences and engineering.

Annual Performance Goal 22: Our performance is successful when, *in the aggregate*, results reported in the period FY 2004 demonstrate significant achievement in the majority of the following indicators:

- Expand opportunities for U.S. researchers, educators, and students at all levels to access state-of the-art S&E facilities, tools, databases, and other infrastructure.
- Provide leadership in the development, construction, and operation of major, next-generation facilities and other large research and education platforms.
- Develop and deploy an advanced cyberinfrastructure to enable all fields of science and engineering to fully utilize state-of-the-art computation.
- Provide for the collection and analysis of the scientific and technical resources of the U.S. and other nations to inform policy formulation and resource allocation.
- Support research that advances instrument technology and leads to the development of next-generation research and education tools.

RESULT: External experts provided examples of significant achievement during FY 2004 reporting. Comments by the AC/GPA and examples they selected are presented for each of the performance indicators and areas of emphasis for this goal.

IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN: This goal will be continued in FY 2005.

TOOLS: Comments by the Advisory Committee for GPRA Performance Assessment

The following statements concerning NSF achievement with respect to the Indicators and Areas of Emphasis for the TOOLS goal are excerpted from the AC/GPA Report on NSF's TOOLS portfolio. Additional comments as well as examples in support of significant achievement for each indicator are available at http://www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf04216.

"The Committee concluded that there is significant achievement in all indicators of the TOOLS strategic outcome goal, which is to provide "broadly accessible, state-of-the-art S&E facilities, tools and other infrastructure that enable discovery, learning and innovation." The essence of TOOLS is to amplify the scientific achievements of the nation by the development and distribution of high-quality tools to various constituents of the community. We found significant achievement in increasing access, in the development of major facilities, the development of cyberinfrastructure, the development of instrument technology, and the collection and analysis of the produced data.

The Committee continues to be concerned about the point made in the FY 2003 AC/GPA Report concerning the tension between ongoing commitments and new awards. This relates to the "big science/small science" issue discussed by NSF Acting Director Bement at our meeting and is intensified by the overextended budget. We feel that budgeting and planning for the operation of major facilities (MREFC) should be more transparent throughout the agency. Once a facility becomes operational, the funding burden shifts to the divisions, pressuring their budgets. It seems that planning for this future pressure could use attention.

A second related issue, especially acute for major facilities but affecting all research grants, is the scheduling and scientific difficulties that funding delays create due to late appropriations. While this is a problem that is not under NSF's control, we still believe it merits mentioning because of the adverse effects it has over time on overall achievement of NSF's (and other agencies') strategic goals."

INDICATOR 1: Expand opportunities for U.S. researchers, educators, and students at all levels to access state-of the-art S&E facilities, tools, databases, and other infrastructure.

RESULT: *Demonstrated significant achievement.*

"The Committee had some difficulty interpreting this meaning of this indicator. Few grants actually satisfied the "and" conjunction of "researchers, educators, and students." It appears that NSF program officers interpreted the conjunction as a disjunction (or), and we followed suit."

INDICATOR 2: Provide leadership in the development, construction, and operation of major, next-generation facilities and other large research and education platforms.

RESULT: *Demonstrated significant achievement.*

The AC/GPA provided examples of nuggets.

INDICATOR 3: Develop and deploy an advanced cyberinfrastructure to enable all fields of science and engineering to fully utilize state-of-the-art computation.

RESULT: *Demonstrated significant achievement.*

The AC/GPA provided examples of nuggets.

INDICATOR 4: Provide for the collection and analysis of the scientific and technical resources of the U.S. and other nations to inform policy formulation and resource allocation.

RESULT: *Demonstrated significant achievement.*

"NSF has supported a wide range of research that contributes to this indicator and the impact appears to be both highly valuable and far-reaching. Some of the work may be categorized as building a supporting infrastructure, for example construction tools to search for critical information efficiently, which will facilitate high quality decisions about policy and resource allocation. Other work is of a more direct technical nature, such as the invention of a tool that will assist in a particular resource allocation problem, leading to more informed decisions of the same type."

"The health of industrial research in the United States is critical to the nation not only from a research perspective but also because of its implication for the economy. It is to be commended that NSF continues to devote resources to improving the statistical and methodological design of its Survey of

Industrial Research and Development. This will assure that the information used by policy makers, among others, will be of the highest quality. NSF is working in collaboration with the Census Bureau's Economic Statistical Methods and Programming Division and with the Committee on National Statistics (CNSTAT) at the National Academy of Sciences."

INDICATOR 5: Support research that advances instrument technology and leads to the development of next-generation research and education tools.

RESULT: ***Demonstrated significant achievement.***

"NSF has demonstrated significant achievement in supporting research that advances instrument technology and leads to the development of next-generation research and education tools. This achievement is demonstrated across a wide range of disciplines, from physics, astronomy, and chemistry, to materials science, biology, and geosciences, to computer science and education. In the following paragraphs we will highlight achievements from three areas: physics/materials science, geosciences, and computer science."

Annual Performance Goal 23: Percent of construction acquisition and upgrade projects with negative cost and schedule variances of less than 10% of the approved project plan.

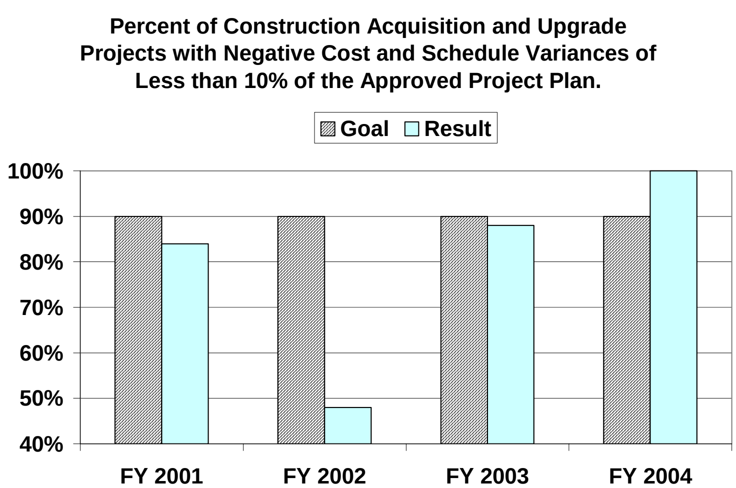
✓ Goal 23 Achieved

In FY 2001 and FY 2002 NSF undertook a comprehensive internal review of the facilities goals. In FY 2003 NSF improved the construction goals by combining cost and schedule performance into a single goal. The revised goal assesses performance based on the Earned Value technique, a widely accepted project management tool for measuring progress that recognizes that cost or schedule data alone can lead to distorted perceptions of performance.

Investments in development, construction of state-of-the-art facilities and platforms are implemented consistently with planned cost and schedule. Through FY 2002, there were three interrelated but separate GPRA goals for schedule and cost for construction/upgrade projects. For FY 2003 and beyond, these goals were combined into the single goal. While annual and total cost targets were all met in FY 2001 and FY 2002, scheduling milestones were not. The goals and actual performance shown (*) for FY 2001 and FY 2002 reflect the schedule goal only. The low number for FY 2002 reflects the requirement that year that facilities meet schedule milestones throughout the year.

PERCENT OF CONSTRUCTION ACQUISITION AND UPGRADE PROJECTS WITH NEGATIVE COST AND SCHEDULE VARIANCES OF LESS THAN 10% OF THE APPROVED PROJECT PLAN.

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Goal	90%	90%	90%	90%	90%
Result	84%	48%	88%	✓**100%**[26]	



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN: This goal will be continued in FY 2005.

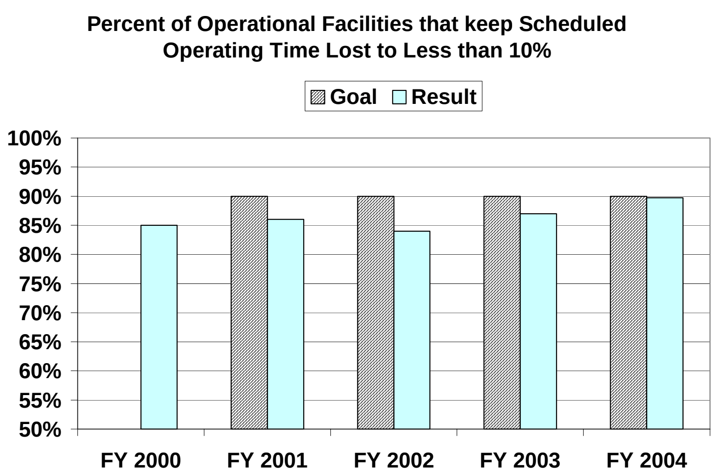
[26] Submissions of cost and schedule estimates for the year occurred later during FY 2004 than in FY 2003 due to changes in the submission process for cumulative Earned Value Management. This could have contributed to the increase in the percentage this year. Note also that starting in FY 2004, polar facilities have their own PART evaluation and efficiency goals (to be reported in the PAR in FY 2006).

Annual Performance Goal 24: Percent of Operational Facilities that keep Scheduled Operating Time Lost to Less than 10%.

✖ Goal 24 Not Achieved

To provide the flexibility necessary for NSF to report realistic goals, we maintained the level deemed "successful" at 90% of the facilities. Measure in FY 2001 and 2002 was based on keeping operating time greater than 90%; results reported here are in terms of present measure.

PERCENT OF OPERATIONAL FACILITIES THAT KEEP SCHEDULED OPERATING TIME LOST TO LESS THAN 10%						
	FY 2000	**FY 2001**	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**
Goal	Keep operating time lost due to unscheduled downtime to less than 10% of the total scheduled operating time.	For 90% of facilities, keep operating time lost due to unscheduled downtime to less than 10% of the total scheduled operating time.	For 90% of facilities, keep operating time lost due to unscheduled downtime to less than 10% of the total scheduled operating time.	For 90% of operational facilities, keep scheduled operating time lost to less than 10%.	For 90% of operational facilities, keep scheduled operating time lost to less than 10%.	For 90% of operational facilities, keep scheduled operating time lost to less than 10%.
Result	22 of 26 (85%) reporting facilities met goal.	25 of 29 (86%) reporting facilities met goal.	26 of 31 (84%) reporting facilities met goal.	26 of 30 (87%) reporting facilities met goal.	**✖26 of 29 (89.7%) reporting facilities met goal.**	



WHY WE DID NOT ACHIEVE THIS GOAL: Some causes of unscheduled operating time losses include the acceleration for the shutdown of another agency's reactor and startup problems with new computer technology.

STEPS WE WILL TAKE TO ACHIEVE THIS GOAL: NSF will continue to work with project managers to identify obstacles to successful performance.

IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN: This goal will be continued in FY 2005.

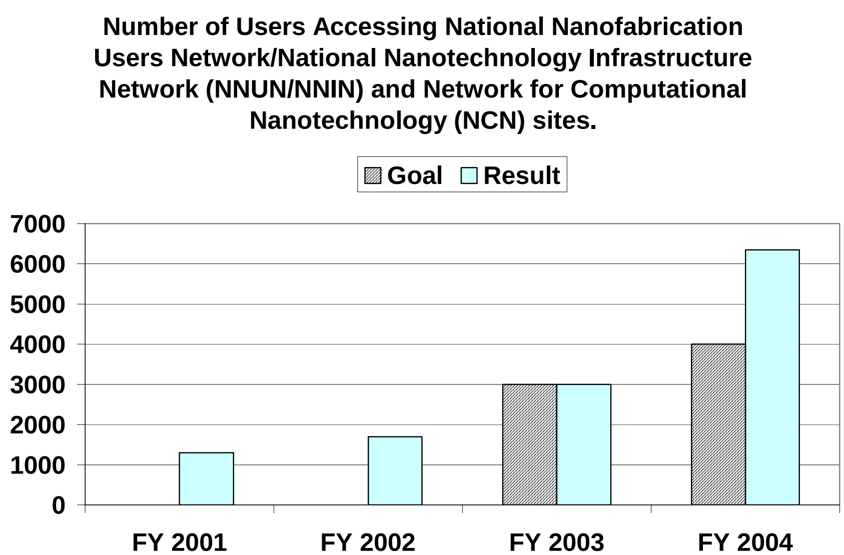
Annual Performance Goal 25: Number of users accessing National Nanofabrication Users Network/National Nanotechnology Infrastructure Network (NNUN/NNIN) and Network for Computational Nanotechnology (NCN) sites.

✓ Goal 25 Achieved

The National Nanotechnology Infrastructure Network (NNIN), is an integrated national network of user facilities that supports the future infrastructure needs for research and education in the burgeoning nanoscale science and engineering field. The facilities comprising this network are diverse in capabilities, research areas, and geographic locations, and the network will have the flexibility to grow or reconfigure as needs arise. The NNIN broadly supports nanotechnology activities outlined in the National Nanotechnology Initiative investment strategy. It provides users across the nation access to leading-edge fabrication and characterization tools and instruments in support of nanoscale science and engineering research. The NNIN supersedes the National Nanofabrication Users Network (NNUN), initiated in 1994 and for which NSF support concluded at the end of 2003.

NUMBER OF USERS ACCESSING NATIONAL NANOFABRICATION USERS NETWORK/NATIONAL NANOTECHNOLOGY INFRASTRUCURE NETWORK (NNUN/NNIN) AND NETWORK FOR COMPUTATIONAL NANOTECHNOLOGY (NCN) SITES

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Goal			3000	4000	4000
Result	1300	1700	3000	**✓6350**	



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN[27]: This goal will be continued in FY 2005.

[27] The FY 2005 Performance Plan has now been integrated within the FY 2005 Performance Budget.

Annual Performance Goal 26: Number of nodes that comprise infrastructure.

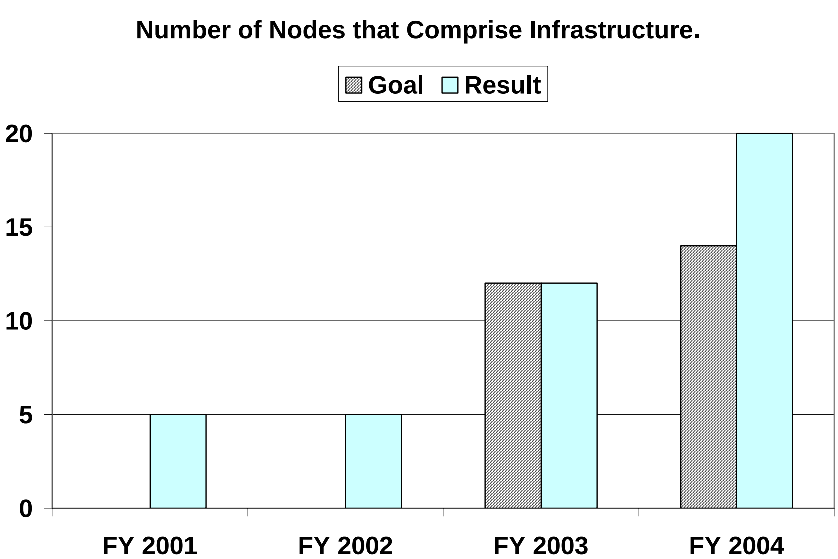
✓ Goal 26 Achieved

The National Nanotechnology Infrastructure Network (NNIN), is an integrated national network of user facilities that supports the future infrastructure needs for research and education in the burgeoning nanoscale science and engineering field. The facilities comprising this network are diverse in capabilities, research areas, and geographic locations, and the network will have the flexibility to grow or reconfigure as needs arise. The NNIN broadly supports nanotechnology activities outlined in the National Nanotechnology Initiative investment strategy. It provides users across the nation access to leading-edge fabrication and characterization tools and instruments in support of nanoscale science and engineering research. The NNIN supersedes the National Nanofabrication Users Network (NNUN), initiated in 1994 and for which NSF support concluded at the end of 2003.

NNIN nodes are defined as both large and small individual user facilities, geographically distributed and with diverse and complementary capabilities to design, create, characterize, and measure novel nanoscale structures, materials, devices, and systems.

NUMBER OF NODES THAT COMPRISE INFRASTRUCTURE.

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Goal			12	14	14
Result	5	5	12	**✓20**	



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN[28]: This goal will be continued in FY 2005.

[28] The FY 2005 Performance Plan has now been integrated within the FY 2005 Performance Budget.

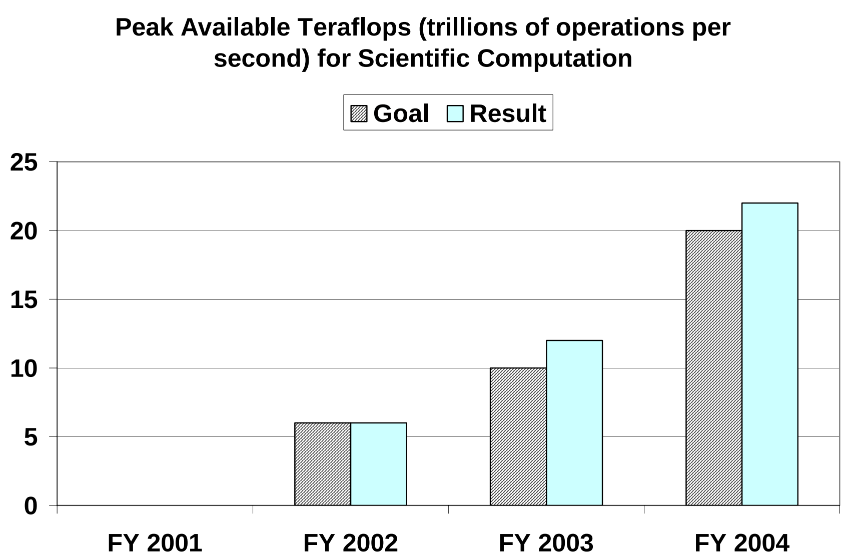
Annual Performance Goal 27: Peak available teraflops (trillions of floating point operations per second) for scientific computation.

✓ Goal 27 Achieved

Teraflops (trillions of floating-point operations per second) are a measure of the power/speed of the computing facilities. About 80% of the quoted numbers are available at any time of the year to the academic and broader scientific community. After FY 2004, NSF will continue to upgrade and improve the ITR funded Terascale Computing facilities and provide the indicated level or higher to S&E users.

PEAK AVAILABLE TERAFLOPS (TRILLIONS OF FLOATING POINT OPERATIONS PER SECOND) FOR SCIENTIFIC COMPUTATION

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Goal	0	6	10	20	
Result	0	6	12	✓**22**	



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN[29]: ITR is no longer a Foundation-wide priority area as of FY 2005. This goal will not continue in FY 2005.

[29] The FY 2005 Performance Plan has now been integrated within the FY 2005 Performance Budget.

Annual Performance Goal 28: External committee finding that research infrastructure is appropriate to enable major discoveries for Nanoscale Science and Engineering (NS&E).

✓ Goal 28 Achieved

The following is taken from the Nanoscale Science and Engineering Committee of Visitors report dated 07/30/2004 Question D.10[30]*, page 35. After reporting to its parent Advisory Committee (Engineering), the report will be available at* *www.nsf.gov/od/gpra/COV/start.htm.*

"The developments are on track for this longer term goal. The availability of multiple funding modes within NS&E is very appropriate for producing enabling technologies. However, before we fully answer this question, it is important to set the stage for generally how things will go in nanoscience and technology in the future. At least in terms of nanotechnology and the end products that come from it, we are still clearly in the first generation of what is often called passive nanostructures (nano-coatings, nano-particles, etc.). These products and uses are novel and important, but just the very beginning. The current developments are on track for establishing a proper infrastructure in the long term. Over the next twenty years or so, experts are anticipating that second, third, and fourth generation developments will occur in the areas of active nanostructures, nanosystems, and heterogeneous molecular nanosystems, respectively (Roco M.C., 2004, AIChE Jounal, 50, 890-897). Therefore, further development of research infrastructure appropriate to enable major discoveries in the future is absolutely critical so that we can reap the benefits from this revolution as soon as possible.

At this time, the answer to question 10 is generally yes, at all levels. The four to five year funding periods for NIRTs and NSECs are conducive to enabling future discoveries when one remembers that nanoscience and engineering technology is still in its infancy, and tremendous strides in research are still occurring with each passing year."

IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN: The next scheduled evaluation of this program is FY 2007. The goal will not appear in FY 2005.

[30] D.10 Is the NS&E-supported research infrastructure appropriate to enable major future discoveries? (Modes of support and themes)?

NSF STRATEGIC OUTCOME GOALS

D. ORGANIZATIONAL EXCELLENCE

People
A diverse, competitive, and globally engaged U.S. workforce of scientists, engineers, technologists and well-prepared citizens.

Ideas
Discovery across the frontier of science and engineering, connected to learning, innovation and service to society.

Tools
Broadly accessible state-of-the-art science and engineering facilities, tools, and other infrastructure that enable discovery, learning and innovation.

Organizational Excellence
An agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices.

ORGANIZATIONAL EXCELLENCE STRATEGIC OUTCOME GOAL: An agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices.

✓ Goal 29 Achieved

Excellence in managing NSF's activities is critical to achievement of the Foundation's mission-oriented outcome goals. Long-term investment categories include *human capital*, which produces a diverse, agile, results-oriented cadre of knowledge workers committed to enabling the agency's mission and to constantly expanding their abilities to shape the agency's future; *business processes*, which produce effective, efficient, strategically-aligned business processes that integrate and capitalize on the agency's human capital and technology resources; and *technologies and tools*, which produce flexible, reliable, state-of-the-art business tools and technologies designed to support the agency's mission, business processes, and customers.

Annual Performance Goal 29: Our performance is successful when, *in the aggregate*, results reported in the FY 2004period demonstrate significant achievement in the majority of the following indicators:

- Operate a credible, efficient merit review system.
- Utilize and sustain broad access to new and emerging technologies for business application.
- Develop a diverse, capable, motivated staff that operates with efficiency and integrity.
- Develop and use performance assessment tools and measures to provide an environment of continuous improvement in NSF's intellectual investments as well as its management effectiveness.

RESULT: External experts provided examples of significant achievement during FY 2004 reporting. Comments by the AC/GPA and examples they selected are presented for each of the performance indicators and areas of emphasis for this goal.

IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN: This goal will be continued in FY 2005.

ORAGANIZATIONAL EXCELLENCE: Comments by the Advisory Committee for GPRA Performance Assessment

The following statements concerning NSF achievement with respect to the Indicators for the ORGANIZATIONAL EXCELLENCE goal are excerpted from the AC/GPA Report on NSF's ORGANIZATIONAL EXCELLENCE at http://www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf04216.

"This strategic outcome goal was added to the NSF Strategic Plan for FY 2003-2008. This is a major step forward in recognizing the linkages between excellence in advancing science and excellence in organizational development. Within the OE goal, the indicators "mirror" the P, I, T structure of the other strategic outcome goals. The Human Capital indicator is the "people" dimension of OE, the Technology-Enabled Business Processes is the 'ideas' dimension of OE, and the Performance Assessment and Merit Review indicators are the 'tools' dimension.

The AC/GPA recommended in its FY2003 report that NSF consider an approach that involved a significant component of 'self study.' This 'self study' would involve a greater number of NSF staff, would be based on NSF's strategic goals and indicators, would be data driven and would provide key information at multiple levels of detail. NSF adopted this approach for the Organizational Excellence goal. Early on, it was determined that the Advisory Committee for Business and Operations (AC/B&O) would provide an assessment of the three of the indicators for the OE goal: Human Capital, Technology-Enabled Business Processes, and Performance Assessment. The AC/GPA would conduct an assessment of the Merit Review indicator since it had, in previous years, looked at this aspect of OE.

The AC/B&O supported NSF's determination that the agency had demonstrated significant achievement for the three indicators it considered. The AC/B&O also made a number of comments to improve the approach, methodology and analysis for the assessment of performance in subsequent years. The letter and the revised assessment are found below. The OE subgroup of the AC/GPA reviewed the letter and the assessment and performed its own review of the merit review indicator. The results of this analysis were presented to the full AC/GPA for its consideration.

With regard to Merit Review, the OE subgroup reviewed data and information from the Report to the National Science Board on the Merit Review Process Fiscal Year 2003, supporting documentation provided by the NSF including a customer survey conducted by Booz, Allen, Hamilton, and the reports from a number of Committees of Visitors (COVs). We concluded that NSF had demonstrated significant achievement for this indicator. While the Merit Review Process will always, in our view, require vigilance and a commitment to continuous improvement, when taken as a whole and when one looks at the results as illustrated in the People, Ideas, and Tools portfolios, clearly, the process remains a major positive force in advancing the frontiers of science, mathematics, and engineering.

With regard to the OE goal as a whole, the AC/GPA inquired as to the extent to which organizational excellence is linked to individual performance goals and the mission and vision of the NSF. NSF staff noted that this practice was started with those NSF employees in the Senior Executive Service two years ago and extended to other employees during the past year. The AC/GPA applauds this and recommends that individual performance goals for all NSF employees continue to be linked to organizational excellence. We believe this will not only have the effect of increasing accountability, but also will encourage and motivate organizational leadership at all levels within the Foundation."

INDICATOR 1: Operate a credible, efficient merit review system.

RESULT: *Demonstrated significant achievement.*

"With regard to Merit Review, the OE subgroup reviewed data and information from the Report to the National Science Board on the Merit Review Process Fiscal Year 2003, supporting documentation provided by the NSF including a customer survey conducted by Booz, Allen, Hamilton, and the reports from a number of Committees of Visitors (COVs). We concluded that NSF had demonstrated significant achievement for this indicator. While the Merit Review Process will always, in our view, require vigilance and a commitment to continuous improvement, when taken as a whole and when one looks at the results as illustrated in the People, Ideas, and Tools portfolios, clearly, the process remains a major positive force in advancing the frontiers of science, mathematics, and engineering. "

INDICATOR 2: Utilize and sustain broad access to new and emerging technologies for business application.

RESULT: *Demonstrated significant achievement.*

Evaluated by the AC/B&O.

INDICATOR 3: Develop a diverse, capable, motivated staff that operates with efficiency and integrity.

RESULT: *Demonstrated significant achievement.*

Evaluated by the AC/B&O.

INDICATOR 4: Develop and use performance assessment tools and measures to provide an environment of continuous improvement in NSF's intellectual investments as well as its management effectiveness.

RESULT: *Demonstrated significant achievement.*

" 'The Human Capital' indicator is the 'people' dimension of OE, the Technology-Enabled Business Processes is the 'ideas' dimension of OE, and the Performance Assessment and Merit Review indicators are the 'tools' dimension.

The AC/B&O supported NSF's determination that the agency had demonstrated significant achievement for the three indicators it considered."

Annual Performance Goal 30: For 70 percent of proposals, be able to inform applicants whether their proposals have been declined or recommended for funding within six months of deadline or target date, or receipt date, whichever is later.

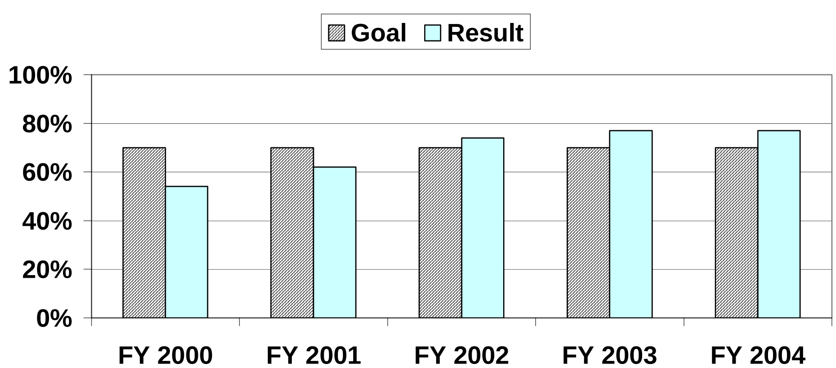
✓ Goal 30 Achieved

One of the most significant issues raised in customer satisfaction surveys is the amount of time it takes us to process proposals. We recognize the importance of this issue.

FOR 70 PERCENT OF PROPOSALS, BE ABLE TO INFORM APPLICANTS WHETHER THEIR PROPOSALS HAVE BEEN DECLINED OR RECOMMENDED FOR FUNDING WITHIN SIX MONTHS OF DEADLINE OR TARGET DATE, OR RECEIPT DATE, WHICHEVER IS LATER.						
	FY 2000	**FY 2001**	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**
Goal	70%	70%	70%	70%	70%	70%
Result	54%	62%	74%	77%	**✓77%**	

In FY 2005, we will continue to focus on improving the efficiency of proposal processing.

For 70 Percent of Proposals, Make Information Available to Applicants on whether their Proposals have been Declined or Recommended for Funding within Six Months of Deadline or Receipt Date, Whichever is Later.



IMPLICATIONS FOR THE FY 2005 PERFORMANCE PLAN[31]: This goal will be continued in FY 2005.

[31] The FY 2005 Performance Plan has now been integrated within the FY 2005 Performance Budget.

IV. ASSESSMENT AND EVALUATION PROCESS

Measuring NSF's Ability to Meet Mission-Oriented Goals

The National Science Foundation's Advisory Committee for GPRA Performance Assessment (AC/GPA) was established in June 2002 to provide advice and recommendations to the NSF Director regarding the Foundation's performance under the Government Performance and Results Act (GPRA) of 1993. The Committee of 20-25 scientists, engineers and educators review NSF's broad portfolio in their analysis of annual progress toward NSF's four strategic outcome goals of People, Ideas, Tools, and Organizational Excellence.

Indicators are used by the Foundation to assess annual progress toward attainment of its long-term outcome goals. For each outcome goal, NSF judges itself successful when, in the aggregate, results reported demonstrate significant achievement for the majority of associated indicators. The AC/GPA's assessment of whether NSF has demonstrated significant achievement with respect to individual performance indicators is based on the collective experience and expertise of the Committee using input from "nuggets" (exemplary outcomes from NSF-funded research), COV reports, PI project reports and input from NSF and the Business and Operations Advisory Committee regarding Organizational Excellence activities. These sources cover NSF's entire portfolio. After its meetings, the AC/GPA provides NSF with a report concerning NSF performance with respect to the indicators associated with each annual performance goal. The recommendations developed by the AC/GPA are used, along with other qualitative information and quantitative management results, to prepare NSF's Performance and Accountability Report.

Project Assessment During NSF Merit Review

Applicants provide results from previous NSF support, information about existing facilities and equipment available to conduct the proposed activity, biographical information on the Principal Investigator(s), other sources of support, federally required certifications, and certifications specific to NSF. Such information is required at the time of application, and in annual and final project reports. It is reviewed by NSF staff, is utilized during merit review, and is available to external committees (COVs and the AC/GPA) conducting performance assessment. The merit review process provides a rigorous, first phase of assessment of NSF's research and education portfolio. Thus, from the onset, only the most competitive one-fourth of proposals submitted for consideration are selected (down from one-third in FY 2001).

Program Officers review the annual progress of awards. The project reports include information on significant accomplishments, progress achieved in the prior year, and points out issues that may impact progress or completion of the project on schedule and within budget. On approval of this report by the Program Officer, NSF releases funds for the ensuing year for continuing grants.

All materials associated with the review of a proposal as well as subsequent annual reports are available to Committees of Visitors. NSF staff also prepare materials (reports, evaluations, highlights) for use by COVs and the AC/GPA in developing their reports and making their assessments.

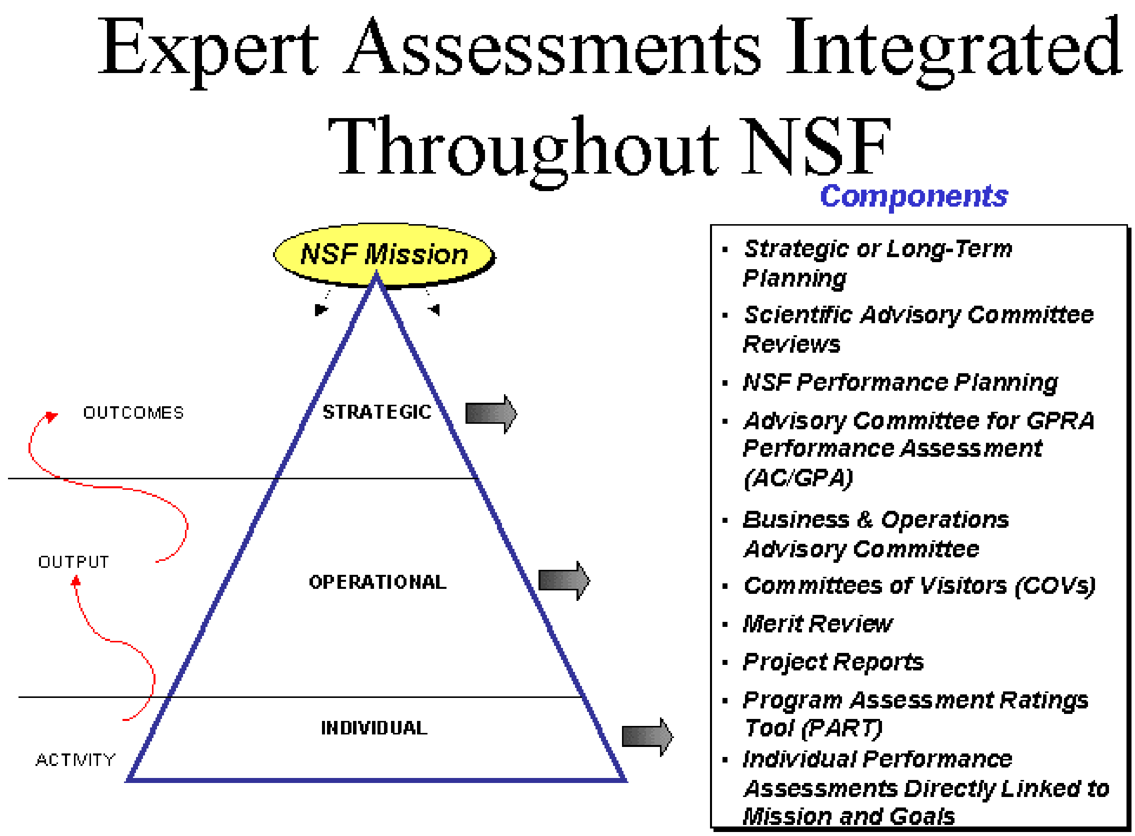


Figure: Shows components and the value of expert evaluations performed at NSF.

Program Assessment by Committees of Visitors (COVs)

NSF's Committees of Visitors provide program assessments that are used both in program management and in annual GPRA reporting. Each COV typically consists of five to twenty external experts who review one or more programs over a two or three day period. These experts are selected to ensure independence, programmatic coverage, and balanced representation. They typically represent academia, industry, government, and the public sector. Approximately one-third of NSF activities are assessed each year.

All COVs are asked to complete a report template with questions addressing how programs contribute to NSF's goals. Questions to Committees of Visitors include: (A) the integrity and efficiency of the *processes* involved in proposal review; and (B) the results, including quality, of NSF's investments.

The FY 2004 COVs were asked to comment on program activities as they relate to NSF's strategic outcome goals. COVs are asked to justify their assessment and provide supporting examples or statements.

COVs are subcommittees of NSF directorate advisory committees. As such, their reports, along with NSF responses to the recommendations made by the COVs, are submitted to the parent advisory committee.

Advisory Committee (AC) Reporting on Directorate/Office Performance

Advisory Committees advise the seven directorates and the Office of Polar Programs. They are typically composed of 18-25 external experts in the respective fields who have broad experience in academia, industry, and government. Advisory Committees are chartered and hence are subject to Federal Advisory Committee Act (FACA) rules. The role of the ACs is to provide advice on priorities, address program effectiveness, and review COV reports and directorate responses to COV recommendations.

In FY 2001 and previous years, directorate advisory committees assessed directorate progress in achieving NSF-wide GPRA goals. With the advent of the AC/GPA, advisory committees no longer assess directorate progress towards these goals.

Advisory Committee for Business and Operations

In FY 2001, NSF established the Advisory Committee for Business and Operations. The committee is composed of 15 members selected from the research administration, education management and business communities, including business professionals and academics in the field. The committee is charged with providing advice on issues related to NSF's business practices and operations, including innovative approaches to the achievement of NSF's strategic goals. This committee provided significant input to the formulation of NSF's Organizational Excellence strategic outcome goal and provided an assessment of NSF performance with respect to three of the four indicators associated with this goal.

Agency GPRA and PART Reporting

NSF has integrated its GPRA and PART reporting. For the second straight year, all performance goals in the Performance and Accountability Report were verified and validated by an external third party. This year, that includes both GPRA and PART goals. The verification and validation (V&V) process is discussed in Section V.

The COV and AC/GPA reports prepared by external experts are integral to the evaluation of NSF performance and address a broad set of issues ranging from staffing and quality of merit review to specifics of a scientific project. The GPRA components of these reports are used in assessing NSF's progress toward achieving its People, Ideas, Tools, and Organization Excellence outcome goals.

The criterion for success for each of the annual performance goals for the strategic outcome goals of People, Ideas, Tools, and Organizational Excellence can be stated:

"NSF is successful when, in the aggregate, results reported in the period demonstrate significant achievement in the majority of the associated indicators."

NSF staff examines statements of significant accomplishment in the AC/GPA to ensure that ratings for the qualitative outcome goals and indicators are justified.

V. Verification and Validation (V&V)

We used a V&V process similar to the one used in FY 2003 to verify and validate all FY 2004 GPRA performance information. For FY 2004 data verification and analyses, we engaged IBMBCS to document the processes we follow to collect, process, maintain, and report all performance data. They identified relevant controls and commented on their effectiveness. Based on General Accounting Office (GAO) guidance, they provided an assessment of the validity and verifiability of the data, policies, and procedures we used to report results for the FY 2004 goals. For the outcome goals, IBM Business Consulting Services reviewed the processes NSF used to obtain external assessment of NSF activities with respect to these goals. IBM Business Consulting Services also provided high-level review of NSF's information systems based on GAO standards for application controls[32].

In their October 2004 report[33], IBM Business Consulting Services states: *"Based on our third quarter and fiscal year-end review, we were able to verify the reliability of the processes and validate the accuracy of all 30 GPRA and PART goals under review. Overall, we conclude that NSF has made a concerted effort to report it s performance results accurately and has effective systems, policies and procedures to promote data quality. We verify that NSF relies on sound business policies, internal controls, and manual checks of system queries to report performance. Finally, NSF maintains adequate documentation of its processes and data to allow for an effective verification and validation review."*

The Foundation has both qualitative and quantitative GPRA and PART goals. Its qualitative goals include annual performance goals that support the strategic outcome goals of People, Ideas, Tools and Organizational Excellence. These outcome goals are presented in a format that requires expert assessment of achievement. These assessments are based largely on information included in reports prepared by committees of independent, external experts (e.g. Committees of Visitors and the Advisory Committee for GPRA Performance Assessment) who assess the quality of program results based on their collective experience-based norms. NSF's quantitative goals provide insight into management activities, enabling assessment of progress toward goal achievement. Assessment for these goals is primarily based on data collected with NSF's central data systems.

TYPES AND SOURCES OF PERFORMANCE DATA AND INFORMATION

Most of the data that underlie achievement assessments for strategic outcome goals (with the exception of the Organizational Excellence goal) originate outside the agency and are submitted to us through the Project Reporting System, which includes annual and final project reports for all awards. Through this system, performance information/data such as the following are available to program staff, third party evaluators, and other external committees:

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

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[32] An executive summary of the IBMBCS report is provided in the Appendix of this Chapter.
[33] Page 1 of the IBMBCS report.

- Information on Ideas – published and disseminated results, including journal publications, books, software, audio or video products created; contributions within and across disciplines; organizations of participants and collaborators (including collaborations with industry); contributions to other disciplines, infrastructure, and beyond science and engineering; use beyond the research group of specific products, instruments, and equipment resulting from NSF awards; and role of NSF-sponsored activities in stimulating innovation and policy development.
- Information on Tools – published and disseminated results; new tools and technologies, multidisciplinary databases; software, newly-developed instrumentation, and other inventions; data, samples, specimens, germ lines, and related products of awards placed in shared repositories; facilities construction and upgrade costs and schedules; and operating efficiency of shared-use facilities.
- Information on Organizational Excellence – information provided by NSF on diversity initiatives, diversity statistics, the NSF Academy and the government-wide eTraining Initiative; information on performance management system improvements, employee recognition activities, innovative capital studies within NSF, the development and implementation of a human capital management plan, and eGovernment human resource initiatives; information on technology enabled business processes, government-wide grants management initiatives, the ePayroll initiative, compliance with the FY 2003 Federal Information Security Management Act (FISMA) Compliance, Greater IT Security Awareness Training Throughout Foundation, and activities associated with GPRA performance assessment.

Most of the data supporting quantitative goals can be found in NSF's central systems. These central systems include the Enterprise Information System (EIS); FastLane, with its Performance Reporting System and its Facilities Performance Reporting System; the Online Document System (ODS); the Proposal and Reviewer System (PARS); the Awards System; the Electronic Jacket; and the Financial Accounting System (FAS). These systems are subject to regular checks for accuracy and reliability.

Data / Information Limitations

For outcome goals, the collection of qualitative data during assessment may be influenced by factors such as a lack of long-term data/information to assess the impact of outcomes, the potential for self-reporting bias, the unpredictable nature of discoveries, and the timing of research and education activities. For the quantitative management goals, the assessment may be influenced by factors such as accuracy of data entry into central computer systems, lack of experience in using new reporting systems or modules, or individual non-responsiveness (e.g., self-reporting of diversity information; workplace surveys).

Finally, external expert assessments (presented in COV and AC/GPA reports) may lack sufficient justification or may provide incomplete information. To address this issue NSF is continuing to modify its reporting templates and improve guidance to committees and staff in order to improve the completeness and consistency of the reports. This will aid in compiling qualitative information.

Judgmental Sampling

With respect to People, Ideas and Tools outcome goals, the AC/GPA is provided with access to recent Committee of Visitor (COV) reports or program assessments conducted by external programmatic expert panels, Principal Investigator project reports, award abstracts, and, since it is impractical for an external committee to review the contributions to the associated performance goals by each of the over 25,000 active awards, NSF Program Officers provided the Committee with nearly 900 summaries of notable results relevant to the performance indicators. Collections obtained from expert sampling of outstanding accomplishments ("nuggets") from awards, together with COV reports and project reports, formed the primary basis for determining, through the recommendations of the external Advisory Committee for GPRA Performance Assessment, whether or not NSF demonstrated significant achievement in its Strategic Outcome Goals for People, Ideas and Tools. The approach to nugget collection is a type of non-probabilistic sampling, commonly referred to as "judgmental" or "purposeful" sampling, that is best designed to identify notable examples and outcomes resulting from NSF's investments. It is the aggregate of collections of notable examples and outcomes that can, by themselves, demonstrate significant agency-wide achievement in the Strategic Outcome Goals. Nevertheless, the combination of COV reports, project reports, award abstracts and notable accomplishments cover the entire NSF portfolio.

In their October 2004 report[34], IBM Business Consulting Services states with regard to the use of "nuggets" by the AC/GPA:

"*As in FY 2003, we reviewed the nuggets based on the GAO auditing standards of materiality, relevance and significance:*[35]

- ***Materiality.*** *In FY 2004, NSF went further to assure adequate materiality by ensuring that the thirty largest NSF programs, by award amount, were represented in the nuggets. As in FY 2003, we conclude that the nuggets materially represent a sufficient share of overall NSF resources, committed to funding research, for the AC/GPA to rely upon to make its assessments*
- **Relevance.** As in FY 2003, we conclude that the distribution of nuggets by directorate adequately represent the level of NSF funding for each directorate. This distribution provides assurance that the diversity of NSF's entire award portfolio is adequately represented in the nuggets provided to the AC/GPA.
- ***Significance.*** *As in FY 2003, we believe that the use of judgmental sampling is appropriate for the purposes of the AC/GPA. Judgmental sampling assures that those programs that NSF professional staff judge as scientifically significant are included in the nuggets for use by the Committee. Because of the importance of applying professional judgment in the selection process, we view the traditional audit approach of random sampling as inappropriate in this instance. It is also important to reiterate that the charge of the AC/GPA is to provide a subjective, qualitative opinion on NSF's outcomes based on a wide range of performance information that extends beyond the nuggets, thus reinforcing the appropriateness of the judgmental sampling approach.***"**

[34] Page 148 of the IBMBCS report.
[35] While we applied GAO auditing standards, this review does not qualify as an audit.

VI. OTHER FEATURES

INFORMATION ON USE OF NON-FEDERAL PARTIES

This GPRA performance report was prepared solely by NSF staff.

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

- Reports from awardees demonstrating results.
- Reports prepared by evaluators – Committees of Visitors (COV) and Advisory Committees – in assessing our programs for progress in achieving Outcome Goals.
- Reports prepared by a consulting firm to assess the procedures we use to collect, process, maintain, and report performance goals and measures.
- Reports from facilities managers on construction/upgrade costs and schedules and on operational reliability.

Specific examples:

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

We use external committees to assess the progress of our programs toward qualitative goal achievement. External evaluators provide us with reports of programs, and provide feedback to us on a report template we prepare. Examples are COV and Advisory Committee reports that provide an independent external assessment of NSF's performance.

We engaged an independent third-party, IBM Business Consulting Services, to conduct a review of data and information used in performance reporting. IBM Business Consulting Services reviewed NSF's performance data and information pertaining to our outcome goals, and management 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.

CLASSIFIED APPENDICES NOT AVAILABLE TO THE PUBLIC

None

ANALYSIS OF TAX EXPENDITURES

None

WAIVERS OF ADMINISTRATIVE REQUIREMENTS

None

National Science Foundation

Government Performance and Results Act (GPRA) and Program Assessment Rating Tool (PART)

Performance Measurement Validation and Verification

Report on FY 2004 Results

October 2004

1 Executive Summary

The National Science Foundation (NSF or the Foundation), as a federal agency, is subject to the performance reporting requirements of the Government Performance and Results Act (GPRA). In addition, NSF measures its programmatic performance using the Office of Management and Budget's Program Assessment Rating Tool (PART). These performance reporting requirements hold Federal agencies accountable for providing detailed information on their progress in meeting performance objectives. Accordingly, NSF measures itself against a series of GPRA and PART goals to help the agency achieve its mission and objectives.

Government Accountability Office (GAO) auditing standards require Federal agencies to provide confidence that the policies and procedures underlying performance reporting are complete, accurate, and consistent. As such, NSF asked IBM Business Consulting Services to assess the validity of the data and reported results of its performance goals and to verify the reliability of the methods used to compile and report data for these performance measurement goals and objectives.[36] Our review consisted of an analysis of NSF's processes and results as of the end of the third quarter and an update review after the end of the fiscal year when final results were reported. FY 2004 is the fifth consecutive year that we have performed this assessment for NSF.

Once again, we commend NSF for undertaking this fifth-year effort to verify the reliability of its processes to collect, process, maintain, and report data for its performance goals and the validity of its reported results. NSF reaffirmed its commitment to reporting accurate and reliable performance results by incorporating its PART process into our verification and validation review for the first time this year. The relative infancy and unique nature of the PART process presented some new challenges to the Foundation in collecting data and developing processes in a relatively short period of time for our review. To address these challenges, NSF staff worked and collaborated extensively to provide us with the necessary data, documentation and access to staff and systems to complete our review. We commend the Foundation for this effort.

Based on our third quarter and fiscal year-end review, we were able to verify the reliability of the processes and validate the accuracy of all 30 GPRA and PART goals under review. Overall, we conclude that NSF has made a concerted effort to report it s performance results accurately and has effective systems, policies and procedures to promote data quality. We verify that NSF relies on sound business policies, internal controls, and manual checks of system queries to report performance. Finally, NSF maintains adequate documentation of its processes and data to allow for an effective verification and validation review.

1.1 Review of Strategic Outcome Goals

NSF measures its overall performance as a Foundation using four Strategic Outcome Goals: People, Ideas, Tools, and a new goal of Organizational Excellence, introduced in FY 2004. A key component of NSF's performance assessment in these areas is the Advisory Committee for GPRA Performance Assessment (AC/GPA), a group of independent experts who offer advice and recommendations to the NSF Director on NSF's achievement on a series of performance indicators related to these Strategic Outcome Goals.

We first assessed the AC/GPA process in FY 2003 with the purpose of verifying the reliability of the process and performance data and the validity of the AC/GPA's conclusions based on the strength of these processes. In FY 2004, NSF asked us to conduct an updated review, focusing on changes from the prior year. To conduct this review, we:

- Reviewed NSF and AC/GPA background information
- Attended the AC/GPA meeting, which took place at NSF on June 22-23, 2004
- Discussed the process with NSF staff and AC/GPA members

[36] GAO defines "verification" as a means to check or test performance data in order to reduce the risk of using data that contains significant errors. GAO defines "validation" as a way to test data to endure that no error creates significant bias.

- Documented the AC/GPA process with emphasis on changes from FY 2003
- Verified the quality of the AC/GPA process to yield valid results
- Assessed the validity of the AC/GPA's conclusions based on the quality of the processes and performance information available

To verify the reliability of the AC/GPA process to produce valid results, we developed eight dimensions on which we assessed the quality of the processes, which are:

- AC/GPA meeting planning: Quality of NSF planning and preliminary review activities to maximize the effectiveness of the AC/GPA meeting and overall quality of the AC/GPA assessment
- AC/GPA scope of review: Expectations and extensiveness of the AC/GPA's review and assessment of NSF's performance
- Membership: Expertise, experience and level of knowledge of the AC/GPA membership
- Performance information: Quality, timeliness, impartiality, and relevance of the information available to the AC/GPA to reach its conclusions
- Independence: Confidence that the Committee's judgment is objective and free from NSF influence
- Determination of achievement: The Committee's determination of "significant achievement" with respect to the annual performance indicators and Foundation-level comments
- Documentation and transparency: Extent to which the AC/GPA process and results are clear, visible and open to review and scrutiny
- NSF's response to AC/GPA recommendations: How NSF responded to the Committee's recommendations in its FY 2003 AC/GPA Report to NSF

1.2 Review of Annual GPRA and PART Goals

In addition to its four Strategic Outcome Goals, NSF measures its performance using 26 other GPRA and PART performance measures, which focus on management and specific program performance. The FY 2004 GPRA and PART measures we reviewed fall under three categories:

- 17 quantitative PART goals, being reviewed for the first time in FY 2004
- Four qualitative PART goals, being reviewed for the first time in FY 2004
- Five quantitative GPRA and PART goals, which we reviewed in prior years, receiving an updated review in FY 2004

As part of our review of the processes and results for the quantitative GPRA and PART goals, we:

- Assessed the accuracy of NSF's performance data and reported outcomes of performance goals and indicators
- Described the reliability of the processes NSF uses to collect, process, maintain, and report data
- Reviewed system controls to confirm that quality input results in quality output
- Created detailed process descriptions and process maps for those goals being reviewed for the first time
- Identified changes to processes and data for those goals receiving an update review

We applied GAO's Guide to Assessing Agency Annual Performance Plans (GAO/GGD-10.1.20) to guide our review. Based on GAO guidance, we assessed whether NSF's processes to collect, process, maintain and report data meet the following criteria:

- Does the process provide for periodic review of collection, maintenance, and processing procedures to ensure they are consistently applied and continue to be adequate?
- Does the process provide for periodic sampling and review of data to ensure completeness, accuracy, and consistency?
- Does the process rely on independent audits or other established procedures for verifying and validating financial information when performance measures require the use of financial information?
- Does NSF address problems in verification and validation procedures, known to GAO or the agency?
- Does the agency recognize the potential impacts of data limitations should they exist?

To assess NSF's qualitative annual PART goals related to Nanotechnology, we followed a methodology similar to the process we used to assess the AC/GPA and the Strategic Outcome Goals. NSF based its results for these qualitative PART goals on an assessment by the Nanotechnology Committee of Visitors (COV). To conduct our review, we analyzed performance data given to the COV; held discussions with NSF staff; documented and assessed the COV review process; and validated the COV's final conclusions. We based our assessment on the expertise and level of knowledge of the COV members; the quality of the data provided to the COV; the independence of the COV from NSF influence; and the overall reliability of the process to yield valid results.

We did not consider the appropriateness of NSF's performance goals or indicators in our assessment of the validity of NSF's reported results. Rather, our validation is based strictly on whether NSF achieved or did not achieve its performance goals based on the accuracy of the performance data and the reliability of NSF's processes.

1.3 Results and Recommendations

Based on our third quarter and fiscal year-end review, we verified the reliability and processes used to collect, process, maintain and report data and results for all 30 GPRA and PART goals we reviewed. Overall, NSF relies on sound business processes, systems and application controls, and manual checks of system queries to report performance. We believe that these processes are valid and verifiable. We also validated the accuracy and reliability of the results reported by NSF for these goals.

We were also able to verify the reliability of the processes and performance data used by the Advisory Committee for GPRA Performance Assessment (AC/GPA). Based on the strength of these processes, we validate the reasonableness of the AC/GPA's conclusion that NSF had demonstrated significant achievement in all the indicators for the Strategic Outcome Goals of People, Ideas and Tools and the Merit Review indicator for the Organizational Excellence Goal.

We summarize the results of our review for each performance goal in the following tables. We indicate the third and fourth quarter results of each goal as reported by NSF in the "Q3 Result" and "Q4 Result" columns. In the "Process Verified" column, a "yes" indicates that we were able to verify the reliability of NSF's processes to collect, process, maintain and report data. In the "Result Validation" column, a "yes" indicates that we were able to validate the accuracy or reasonableness of NSF's reported results for the corresponding performance goal. Finally, where appropriate, we also summarize any significant observations, recommendations or issues for consideration we determined through our review of each goal. The full results of our review are discussed in greater detail in the balance of this report.

NSF FY 2004 Strategic Outcome Goals Indicators: Verification and Validation Summary

FY 2004 GPRA Strategic Outcome Goals	AC/GPA Assessment	Process Verified	Results Validated
Goal 1: People – A diverse, competitive, and globally-engaged U.S. workforce of scientists, engineers, technologists and well-prepared citizens ▪ P1: Promote greater diversity in the science and engineering workforce through increased participation of underrepresented groups and institutions in all NSF programs and activities ▪ P2: Support programs that attract and prepare U.S. students to be highly qualified members of the global science and engineering workforce, including providing opportunities for international study, collaborations and partnerships ▪ P3: Develop the Nation's capability to provide K-12 and higher education faculty with opportunities for continuous learning and career development in science, technology, engineering and mathematics ▪ P4: Promote public understanding and appreciation of science, technology, engineering, and mathematics, and build bridges between formal and informal science education ▪ P5: Support innovative research on learning, teaching and mentoring that provides a scientific basis for improving science, technology, engineering and mathematics education at all levels	Achieved	Yes	Yes
Goal 13: Ideas – Discovery across the frontier of science and engineering, connected to learning, innovation, and service to society ▪ I1: Enable people who work at the forefront of discovery to make important and significant contributions to science and engineering knowledge ▪ I2: Encourage collaborative research and education efforts – across organizations, disciplines, sectors and international boundaries ▪ I3: Foster connections between discoveries and their use in the service of society ▪ I4: Increase opportunities for underrepresented individuals and institutions to conduct high quality, competitive research and education activities ▪ I5: Provide leadership in identifying and developing new research and education opportunities within and across science and engineering fields ▪ I6: Accelerate progress in selected science and engineering areas of high priority by creating new integrative and cross-disciplinary knowledge and tools, and by providing people with new skills and perspectives	Achieved	Yes	Yes

FY 2004 GPRA Strategic Outcome Goals	AC/GPA Assessment	Process Verified	Results Validated
Goal 22: Tools Goal – Broadly accessible, state-of-the-art science and engineering facilities, tools and other infrastructure that enable discovery, learning and innovation ▪ T1: Expand opportunities for U.S. researchers, educators, and students at all levels to access state-of-the-art science and engineering facilities, tools, databases, and other infrastructure ▪ T2: Provide leadership in the development, construction, and operation of major, next-generation facilities and other large research and education platforms ▪ T3: Develop and deploy an advanced cyber-infrastructure to enable all fields of science and engineering to fully utilize state-of-the-art computation ▪ T4: Provide for the collection and analysis of the scientific and technical resources of the U.S. and other nations to inform policy formulation and resource allocation ▪ T5: Support research that advances instrument technology and leads to the development of next-generation research and education tools	Achieved	Yes	Yes
Goal 29: Organizational Excellence Goal – An agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices Merit Review Indicator: Operate a credible, efficient merit review system[37]	Achieved	Yes	Yes

[37] The Organizational Excellence Goal indicators of Human Capital, Performance Assessment, and Technology-Enabled Business Processes were assessed by the NSF Advisory Committee for Business and Operations.

NSF FY 2004 Annual GPRA and PART Goals: Verification and Validation Summary

FY 2004 GPRA and PART Goals	Target	Q3 Result	Q4 Result	Process Verified	Results Validated	Issues for Consideration
Goal 2: Number of U.S. students receiving fellowships through Graduate Research Fellowships (GRF) and Integrative Graduate Education and Research Traineeships (IGERT)	Increase from 3328	3870	Achieved 3681	Yes	Yes	▪ Examine and identify the causes for data errors, due to double-counting and miscoding of GRF students, in the GRFP module in Fastlane, which NSF appropriately identified and corrected.
Goal 3: Stipend level for Graduate Research Fellowships (GRF) and Integrative Graduate Education and Research Traineeship (IGERT) awards (dollars/year)	$30,000	Not Applicable	Achieved $30,000[38]	Yes	Yes	▪ Automate process to calculate institution "carry-over" funds from prior year to determine GRF funding amount for upcoming academic year. ▪ Integrate the Graduate Research Fellowship Program (GRFP) system and the IGERT project reporting process with NSF's Central System to eliminate manual entry.
Goal 4: Number of applicants for Graduate Research Fellowships from groups that are underrepresented in the science and engineering workforce.	Increase from 820	932	Achieved 1009	Yes	Yes	None
Goal 5: Number of applicants for Faculty Early Career Development Program (CAREER) awards from investigators at minority-serving institutions	Increase from 67	81	Achieved 82	Yes	Yes	None

[38] We note that the institutions funded by NSF are ultimately responsible for disbursing GRF and IGERT stipends to students at the $30,000 level. While these disbursements occur after the end of the federal fiscal year (during the 2004-2005 academic year) and therefore after the period of our review, we can validate that NSF achieved this goal based on the reliability of its funding processes and controls to assure a $30,000 stipend level, including the NSF grant agreement and Congressional law.

FY 2004 GPRA and PART Goals	Target	Q3 Result	Q4 Result	Process Verified	Results Validated	Issues for Consideration
Goal 6: Percent of Nanoscale Science and Engineering (NS&E) proposals with at least one female principal investigator (PI) or co-principal investigator (Co-PI)	25%	24%	Achieved 26%	Yes	Yes	None
Goal 7: Percent of Information Technology Research (ITR) proposals with at least one female PI or Co-PI	25%	36%	Achieved 29%	Yes	Yes	None
Goal 8: Percent of Nanoscale Science and Engineering (NS&E) proposals with at least one minority PI or co-PI	13%	12%	Not Achieved 12%	Yes	Yes	None
Goal 9: Percent of ITR proposals with at least one minority PI or Co-PI	7%	8%	Achieved 9%	Yes	Yes	None
Goal 10: Percent of NS&E proposals that are multi-investigator proposals	75%	78%	Achieved 80%	Yes	Yes	None
Goal 11: Percent of ITR proposals that are multi-investigator	50%	67%	Achieved 62%	Yes	Yes	None
Goal 12: Successful development of workforce, as qualitatively evaluated by external experts for NS&E	On-Track	Achieved Based on NS&E COV draft report	Achieved Based on NS&E COV final report	Yes	Yes	None
Goal 14: Qualitatively assessment by external experts that program is responsible for a broad-based and capable interdisciplinary research community that advances fundamental nanotechnology knowledge, with impact on other disciplinary fields	On-Track	Achieved Based on NS&E COV draft report	Achieved Based on NS&E COV final report	Yes	Yes	None
Goal 15: As qualitatively evaluated by external experts,	On-Track	Achieved	Achieved	Yes	Yes	None

FY 2004 GPRA and PART Goals	Target	Q3 Result	Q4 Result	Process Verified	Results Validated	Issues for Consideration
the successful development of a knowledge base for systematic control of matter at the nanoscale level that will enable the next industrial revolution for the benefit of society		Based on NS&E COV draft report	Based on NS&E COV final report			
Goal 16: NSF will increase the average annualized award size for research grants to $139,000	$139,000	$123,236	Achieved $140,000	Yes	Yes	None
Goal 17: Average annualized new research grant award size (in dollars) within NS&E solicitation.	$330,000	$135,422[39]	Achieved $336,000	Yes	Yes	None
Goal 18: Average annual award size for new ITR research grants.	$230,000	$349,494	Achieved $336,000	Yes	Yes	None
Goal 19: The average duration of awards for research grants will be 3.0 years	3.0	3.01	Not Achieved 2.96	Yes	Yes	None
Goal 20: Average award duration of new ITR research grants (in years)	3.3	3.8	Achieved 3.7	Yes	Yes	None
Goal 21: Average duration (in years) of new research grant awards for Nanoscale Interdisciplinary Research within the NS&E solicitation	3.8	1.26	Achieved 3.9	Yes	Yes	None
Goal 23: Percent of construction acquisition and upgrade projects with negative cost and schedule variances of less than 10% of the approved project plan	90%	No Results	Achieved 100%	Yes	Yes	▪ Formally require and standardize the collection of facilities performance and progress documentation ▪ Require PIs to formally submit work breakdown structures (WBS) online to the Program Officer

[39] NSF's third quarter results for Goal 17 include three types of NS&E awards: Nanoscale Interdisciplinary Research Teams (NIRT), Nanoscale Exploratory Research (NER), and Nanoscale Science and Engineering Centers (NSEC). However, the purpose of this goal is only to measure NIRT award sizes. As such, the fourth quarter results only reflect NIRT awards

FY 2004 GPRA and PART Goals	Target	Q3 Result	Q4 Result	Process Verified	Results Validated	Issues for Consideration
Goal 24: Percent of operational facilities that keep scheduled operating time lost to less than 10%	90%	No Results	Not Achieved 89.7%	Yes	Yes	Formally require and standardize the collection of facilities performance and progress documentation
Goal 25: Number of users accessing National Nanofabrication Users Network/National Nanotechnology Infrastructure Network (NNUN/NNIN) and Network for Computational Nanotechnology (NCN) sites	4000	None Reported	Achieved 6350	Yes	Yes	None
Goal 26: Number of nodes that comprise infrastructure	14	20	Achieved 20	Yes	Yes	None
Goal 27: Peak available teraflops (trillions of floating point operations per second) for scientific computation	20	22.49	Achieved 22.49[40]	Yes	Yes	None
Goal 28: External Committee finding that research infrastructure is appropriate to enable major discoveries for NS&E	On-Track	Achieved Based on NS&E COV draft report	Achieved Based on NS&E COV final report	Yes	Yes	None
Goal 30: For 70% of proposals, be able to inform applicants whether their proposals have been declined or recommended for funding within six months of receipt	70%	79%	Achieved 77%	Yes	Yes	None

[40] NSF rounded this figure to 22 Teraflops for the final FY 2004 results.