III. NSF STRATEGIC OUTCOME GOALS

Introduction to Section III: NSF Strategic Outcome Goals

NSF assessment activities are based on an OMB-approved alternative reporting format that utilizes external expert panels 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 Committee of Visitors and Directorate Advisory Committees[12].

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 National Science Foundation (NSF) Director regarding the Foundation's performance under the Government Performance and Results Act (GPRA) of 1993.

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

(1) An assessment of NSF retrospective results for indicators associated with the PEOPLE, IDEAS, and TOOLS strategic outcome goals;
(2) Comments on the quality/relevance/balance of NSF award portfolios; and
(3) Comments on NSF investment portfolios for their potential future impact.

The format of Section III is the following:

- An NSF assessment of performance with respect to the strategic outcome goal;
- Comments by the AC/GPA concerning the strategic outcome goal; and
- For each indicator or area of emphasis associated with a strategic outcome goal:
    - Comments by the AC/GPA,
    - Retrospective and prospective examples selected by AC/GPA.

A Diverse, Balanced Portfolio

Maintaining a diverse, balanced portfolio of high quality is an essential aspect of any investment strategy, and this holds true for investments NSF makes in science and engineering research and education. We recognize that there is a significant probability of failure associated with high-risk research, that there is often a lack of experimental data or methodologies, little consensus on theory, information and/or approach. If successful, however, such high-risk research can result in a significant advance in a scientific or technological field. In addition to our regular grants, our Small Grants for Exploratory Research (SGER) are meant to encourage Program Officers to invest in new, innovative concepts and ideas and to support small-scale, high-risk exploratory work.

Our external reviewers assessed our investment portfolio for FY 1999, FY 2000 and FY 2001 with respect to quality and balance. The vast majority of their comments indicated that investments made by the Directorates contained an appropriate balance of high-risk, multidisciplinary or innovative activities. Some comments from the AC/GPA and Committee of Visitors (COV) on quality and balance follow.

[12] See Section V for further details on these committees.

AC/GPA and COV FY 2002 comments on quality

"Overall, the Committee found that COVs judged the quality of the portfolio to be high. COVs found that in some cases proposals were not funded due to lack of money, not lack of quality. However, as would be expected in a portfolio of about 30,000 active awards, there is some evidence of variability in quality in parts of the portfolio. But the COVs did not appear to detect specific or systemic patterns of variability." (AC/GPA)

"The COV finds the overall quality of funded research and education proposals to be very high; NSF support continues to be the gold standard for ecologists. Scientists who submit proposals to NSF and to Ecological Studies in particular are aware of the high degree of competition for the funds, and the stringent review process assures that only high quality research is funded."

"The quality of the research that is funded is outstanding. There is a set of declined proposals that would also fit into this category, presumably due to insufficient funds."

"In general, the quality of the research projects is excellent."

"The funded projects in this portfolio are of variable quality in relation to the goals of the IERI initiative."

"Based on a review of the lists of funded projects, the contents of selected jackets, and the COV members' knowledge of many of the IMD projects, the COV judged the quality of the funded projects to be very high."

"We noted that the scores, on average, assigned to both the declined and funded NSDL proposals are lower than expected. See our comments below on this matter."

"The quality is high and the projects are diverse."

"The quality of research and education projects across the Division were deemed to be high and meritorious. Combined high quality in both research and education are components of successful proposals."

"The quality of research is consistently of the highest caliber."

"The overall quality of research and education projects that we saw was outstanding."

"The range of the STR portfolio was most impressive."

"The Geophysics program has been extraordinarily successful in stimulating and fostering discoveries across a broad range of topics."

"The HS Program has now established a track record of supporting excellent science across a remarkably broad spectrum of hydrologic research."

"This program is funding high quality fundamental research."

"The funded projects in this portfolio are of variable quality."

"Work funded by the program has been of excellent quality, focusing on first-rate problems."

"The CD program has matured into a collection of primarily large projects, wherein first order global processes are being studied effectively and basic earth science discoveries are being made."

"As summarized in the reports for the individual programs, the COV was greatly impressed with the excellent results being achieved in every Program. EAR awards are leading to advances of major scientific or engineering importance."

"Overall, the work supported by the division is world class and absolutely at the cutting edge of research. The programs are a powerful and constructive force in shaping the educational environment of the nation."

"Funding rate appeared to differ dramatically across disciplines (Among the jackets reviewed, geosciences had a high success rate; social sciences had a low rate.) It should be determined whether this is true across all proposals and, if so, whether or not this serves INT and NSF goals."

AC/GPA and COV FY 2002 comments on innovative, risky, and multi-disciplinary research and education

"Thus, the Committee has confidence that NSF is appropriately attending to the need for both high-risk and multidisciplinary research and education as a key element in the overall portfolio. However, over time, NSF should attempt to collect more direct data on both the amount and the effectiveness of its investment in interdisciplinary research."

"71% of funded proposals were identified as especially innovative, but the COV emphasizes that essentially all funded proposals are innovative, especially given the high degree of competition for funding."

"High Risk: Very few of these were identified and even fewer were supported. The majority of funded labs have received multiple awards or are associated with well-known major institutions; in general, the program made very conservative funding decisions. This pattern could constrain the contributions made to the overall People goals of NSF."

"As would be expected for proposals submitted to this category, the majority of proposals had elements of high risk. This indicates that the program announcements solicit applications from the appropriate sectors of the scientific community. Thus, the concerns identified by the 1998 COV report appear to have been resolved. In addition, NSF is doing an adequate job in using the SGER to initiate high risk projects. However, the actual number of SGER awards made over this review period appears to be only 2%."

"The COV notes that the definition of high-risk is extremely subjective. However, based on the identification of high-risk proposal by the panels, the percentage of such proposals that is funded is increasing. We believe this is a good trend but needs to increase."

"The data are not available to determine the proportion of proposals that are multidisciplinary."

"This category of proposals is difficult to assess as the COV thought all proposals should be innovative. The COV was uncertain of what the Foundation means by the term 'innovative'."

"The COV finds that, in general, the funded projects are of high quality and that there is a balance of high risk, multidisciplinary, and innovative proposals."

"The whole NSDL program is high risk. Even taking this into account, we believe that the program is doing a good job funding high risk proposals."

"Multidisciplinarity is a hallmark of the NSDL program."

"The COV found that the jackets reviewed demonstrated high levels of innovation."

"The majority of awards in the portfolio of the Division are multidisciplinary; a balance that is deemed fully appropriate."

"Successful proposals in cluster solicitations are uniformly innovative."

"The number of proposals identified as high risk is relatively small."

"There appears to be sufficient balance of multidisciplinary proposals within the Aeronomy Program. The number of cross-disciplinary proposals is relatively small."

"The proposal pressure from the community generates more innovative proposals than can reasonably be funded. The review process and the panel process combine to insure that the most innovative proposals rise to the top."

"Despite strong division and directorate statements in support, multidisciplinary research appears to be treated in an ad hoc basis within EAR with any attempts to address specific proposals dependent on personal relations among Program Officers."

"None of the EAR programs identify innovation as a target for consideration in the review process."

"High Risk Proposals. The number of proposals in this class seems appropriate but certainly remains at a level where further expansion could be supported."

"The innovation exhibited in the proposals was remarkably high."

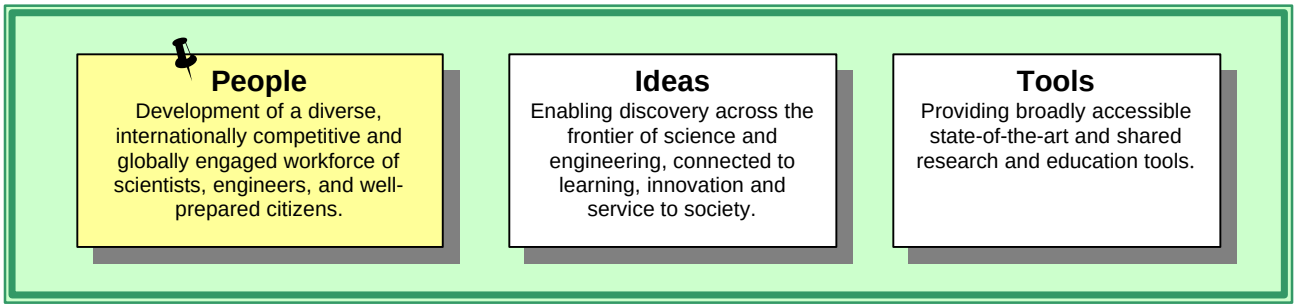
"Few multidisciplinary projects were noted in the jackets, although the COV learned of their existence."

"The technical risk of funded projects is generally low, although other elements of risk are apparent."

"The level of innovation in the funded projects is appropriate."

III. NSF OUTCOME GOALS

A. PEOPLE



STRATEGIC OUTCOME GOAL III-1a: Development of "a diverse, internationally competitive and globally engaged workforce of scientists and engineers, and well-prepared citizens."

✓ Goal Achieved

To achieve this outcome, we invest in the best and brightest students, researchers and educators to ensure a well-prepared workforce and citizenry. We provide support for formal and informal science, mathematics, engineering and technology education at all levels – pre K-12, undergraduate, graduate – in addition to professional development and public science literacy projects that engage people of all ages in life-long learning. Our efforts serve as a catalyst and a test bed for a gradual change in the process and philosophy of educating the workforce.

Our performance for this goal is successful when, in the aggregate, results reported for the period FY 2002 demonstrate significant achievement for four of the seven of the following indicators:

- Development of well-prepared scientists, engineers or educators whose participation in NSF activities provides them with the capability to explore frontiers and challenges of the future;
- Improved science and mathematics performance for U.S. K-12 students involved in NSF activities;
- Professional development of the SMET instructional workforce involved in NSF activities;
- Contributions to development of a diverse workforce through participation of underrepresented groups (women, underrepresented minorities, persons with disabilities) in NSF activities;
- Participation of NSF-supported scientists and engineers in international studies, collaborations, or partnerships;
- Enhancement of undergraduate curricular, laboratory, or instructional infrastructure; and
- Awardee communication with the public in order to provide information about the process and benefits of NSF supported science and engineering activities.

RESULT FOR PERFORMANCE GOAL III-1a: Reports prepared by external experts provided examples of significant achievement in reports they developed during FY 2002 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 2003 Performance Plan: This goal will be continued in FY 2003.

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

The following statements concerning NSF achievement with respect to the Indicators and Areas of Emphasis 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/od/gpra/reports/final_report_1107.doc

"The PEOPLE Indicator retrospective portfolio was impressive in its diversity, breadth, and impact. Significant achievements were accomplished in all areas of the People portfolio. A detailed discussion of the specific indicators for this portfolio can be found in Appendix 1 of this report. Program nuggets varied from small highly focused programs to international and broad impact ones. Program participants are equally varied, from pre-school teachers to graduate level students; from pre-school teachers to graduate school faculty; from two to three students in a research project to programs affecting thousands of students and/or teachers. The portfolio includes pre- and in-service teacher training programs; research experiences for students and teachers; internship opportunities and professional development workshops. Undergraduate research experiences teach research methodology and stimulate interest in science, technology, engineering and mathematics (STEM) professions.

INDICATOR 1: Development of well-prepared scientists, engineers or educators whose participation in NSF activities provides them with the capability to explore frontiers and challenges of the future.

RESULT: *Demonstrated significant achievement.*

"One critical component of NSF's portfolio includes programs and funding opportunities that explore the human infrastructure dimension. This "People" component contains important activities that expose students to non-traditional career choices, graduate school, and interdisciplinary employment opportunities in science, technology, engineering and mathematics. The nuggets clearly indicate a balance of programs ranging from K-12 through the support of senior investigators. In some programs a large number of students are impacted, while in others a smaller number of discipline specific students are participants. The emphasis and strategies used to develop and train STEM scientists, educators, and engineers are innovative and of high quality. Some are high risk and provide opportunities for non-traditional students, or utilize other strategies that increase student opportunities. Providing scholarships for students who also must hold full time jobs is an effective strategy to increase the pool of STEM students."

INDICATOR 2: Improved science and mathematics performance for U.S. K-12 students involved in NSF activities.

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

"While retrospective results clearly demonstrate improved science and mathematics performance for U.S. K-12 students involved in NSF activities, the prospective analysis confirms agency's commitment to the development of 'a diverse, internationally competitive and globally engaged workforce'.

The overall quality of the retrospective portfolio of outcomes and outputs reported in FY 02 in the area of improving science and mathematics performance for U.S. K-12 students is impressive. The supported programs clearly emphasize the many aspects and variables essential to improving science and mathematics performance of K-12 students."

INDICATOR 3: Professional development of the SMET instructional workforce involved in NSF activities.

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

"Based on review of information provided, the Committee concludes that NSF has made significant achievements in developing the STEM instructional workforce. NSF grants have supported a variety of activities, several of which are pervasive and nationally replicable models of teacher professional development. The portfolio includes pre- and in-service teacher training programs; research experiences; internship opportunities and professional development workshops. There were several programs that provided research experience for faculty. Some of these had associated workshops designed to present techniques for translating research experience in areas as diverse as astronomy, marine biology, arctic biology into classroom instruction."

INDICATOR 4: Contributions to development of a diverse workforce through participation of underrepresented groups (women, underrepresented minorities, persons with disabilities) in NSF activities.

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

"Overall the accomplishments presented in the Retrospective Analysis are of very high quality and demonstrate methodologies that are making a difference in developing a diverse, internationally competitive work force of scientists and engineers. This does not mean however that this is a comprehensive, all-inclusive set of strategies."

"LSAMP is one of the most important programs contributing to significant achievement in this indicator. This is an example of successful demonstration project being selected for large-scale implementation by

NSF via implementation by a wide variety of educational institutions with the intention of substantially increasing participation by underrepresented populations in STEM activities and careers."

INDICATOR 5: Participation of NSF-supported scientists and engineers in international studies, collaborations, or partnerships.

RESULT: *Demonstrated significant achievement.*

"Many NSF PIs have conducted NSF-supported research that involves international activities. Some PIs have established cooperation on an individual basis with peers in other countries; others have created partnerships involving multiple organizations. In some cases, there is evidence that the level of engagement with the international participants is very high, resulting in co-authorship peer-reviewed publications."

INDICATOR 6: Enhancement of undergraduate curricular, laboratory, or instructional infrastructure

RESULT: *Demonstrated significant achievement.*

"Review of the retrospective portfolio addresing the enhancement of undergraduate curricular, laboratory, or institutional infrastructure clearly demonstrates successful accomplishment of the stated goal. Review of the prospective portfolio attests to the Agency's continued commitment to enhancing the undergraduate curricular, laboratory, and/or instructional infrastructure.

Innovation, collaboration, broad dissemination, and the potential for significant and extensive impact characterize programs in the PI 6 retrospective portfolio. Programs are broad in scope. Examples of programs in this portfolio include: involvement of liberal arts faculty from several liberal arts colleges working with STEM faculty in a summer program to develop modular case studies; development of new courses; new curricula such as neuroinformatics and bioinformatics; establishment of virtual laboratories; development of virtual laboratory experiments; a tactile printing technique enabling blind people to access scientific information; and outstanding faculty development programs. Through these programs NSF is building the educational research base and providing support for innovative instructional approaches, and faculty development. Leaders of 703 projects indicated that 1,923 faculty from doctorate-granting institutions, 549 from master's degree granting institutions, 1,657 from bachelor's degree granting institutions, and 772 from associate-degree granting institutions have been trained. A number of students, faculty, and individual programs in this portfolio have received state, regional, and national awards.

The retrospective and prospective portfolios clearly attest to NSF's commitment to innovation, and multi-disciplinary research and education. The awarded programs demonstrate NSF's response to the Nation, and science and technology fields. The overall quality of thse\programs is impressive. The competitive merit-based mechanism, such as the peer-review award process is effective and successful in addressing the agency goals and indicators, and in fostering innovation, creativity, and growth in mathematics and science fields."

INDICATOR 7: Awardee communication with the public in order to provide information about the process and benefits of NSF supported science and engineering activities.

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

"These data in this section were limited in nature. Nevertheless, these selected activities are illustrative of the creative approaches that many prinicipal investigators take to disseminate their results to a broader audience and to get the pubic involved in scientific activities. The activities were both large (e.g., observatory) and small (.e.g., writing a memoir) but all had the same goal—communicate scientific results to and get the public involved in the scientific endeavor. These efforts demonstrate that even the most complex issues in science can be made accessible to the broader public."

Area of Emphasis 1: K-12 Education: The President's Math and Science Partnership.

"Progress towards improving student achievement in math and science has been impressive in urban and rural schools. In all cases, test scores have improved. In some cases, there have been significant improvement in narrowing the performance gap between majority and minority students. Performance increases are attributed to: (1) special local efforts such as targeting reform efforts at lower grades and providing additional support for at-risk students; (2) implementation of standards-based curriculum; (3) teacher participation in math/science content institutes or other subject area professional development activities; (4) adoption of state curriculum guides/frameworks and national standards."

Area of Emphasis 2: Learning for the 21st Century (Centers for Learning and Teaching; NSF Graduate Teaching Fellows in K-12 (GK-12) Education).

"The Centers for Learning and Teaching are developing pedagogy and technology to rebuild the intellectual infrastructure to ensure high-quality educational experiences for all students. Many projects involve multiple institutions and disciplines.

The GK-12 program is significantly increasing the quantity and quality of professionals to serve as content resources in the K-12 classroom. Fellows are positive role models for students. Teachers feel less risk when working with them. They bring new knowledge to the classroom."

Area of Emphasis 3: Broadening participation (Minority Serving Institutions Program)

"The accomplishments in this section are drawn heavily from EPSCoR and Minority Serving Institutions. There are no accomplishments from the Minority Institutions Infrastructure Program. Nevertheless, the accomplishments suggest that there is substantial activity on the part of NSF recepients to include underrepresented minorities in research and education projects, and to recruit and retain them in careers in science and engineering. Clearly, more needs to done in this area, but the accomplishments reviewed are illustrative of some of the successful programs that will go a long way toward increasing the number of minorities in science and engineering activities and careers. NSF should be applauded for its efforts, but must continue its commitment and increase its activities in this area. Success will come only with sustained programmatic and financial resources over the next several decades."

Area of Emphasis 4: Graduate Student Stipends, *e.g.,* Increasing stipends of GRF, IGERT, and GK-12.

"NSF's successful advocacy for increases in graduate student stipends has made these fellowship programs more attractive. In 2002, fewer applicants rejected fellowships to accept ones with higher stipend or longer duration. NSF is encouraged to keep a focus on maintaining attractive grant programs that will attract and retain students in STEM fields."

No examples provided by NSF."

STRATEGIC OUTCOME GOAL III-1b: After three years of NSF support, over 80 percent of schools participating in systemic initiative programs will: (1) implement a standards-based curriculum in science and mathematics with at least one-third of their teachers; (2) provide professional development for at least one-third of their teachers; and (3) improve student achievement on a selected battery of math and science tests at one or more of three educational levels (elementary, middle and high school).

✓ Goal Achieved

NSF manages a portfolio of programs that encourages and facilitates coordinated approaches to systemic, standards-based reform of science, mathematics, and technology (SMET) education. Systemic reform relies on partnerships to identify needs, articulate visions, and develop goals, strategies, and activities for improvement of targeted areas. Although each systemic initiative is unique in its approach, all must begin as a collaborative effort among individuals and organizations that are committed to requiring high expectations for all students through challenging educational opportunities. Systemic initiatives cultivate coordination within cities, states, rural areas, school systems, and other organizations involved with education.

In terms of the implementation of standards-based curriculum process, NSF requires that awardees certify that the curriculum materials they are adopting are consistent with their locally developed standards and demonstrate improved student learning as a result of the use of such standards-based curriculum. For the purpose of this report, curriculum implementation only refers to actual classroom use, excluding processes, such as planning, examining, or adopting a standards-based curriculum. In addition, data reflects only schools in which at least one-third of the teachers are utilizing such as curriculum.

RESULTS: NSF achieved this goal. Systemic Initiatives (SI) projects reported that 93.1% of their schools met the GPRA goal for mathematics curriculum implementation, while 91.3% met the goal for the implementation of science curriculum. In mathematics, 94.0% of elementary schools, 94.5% of middle schools, and 91.0% of high schools met the goal. Similarly, in science, 92.6% of elementary schools, 90.4% of middle schools, and 90.5% of high schools attained the goal. For professional development 96% of the SI schools reported meeting the goal for mathematics professional development and 95% met the goal for science professional development. Finally SI projects reported that at the middle school level 87% of participating schools met the goal of improved student achievement in math and 86% met the goal of improved student achievement in science.

FY 1999 Result: In 1999, 46 NSF-sponsored projects implemented mathematics and science standards-based curricula in over 81% of participating schools, and provided professional development for more than 156,000 teachers. All participating educational systems demonstrated some level of improvement in student achievement in mathematics and science.

FY 2000 Result: In 2000, 47 Systemic Initiative projects implemented mathematics and science standards in over 80% of the participating schools and provided professional development for more than 214,792 teachers. The Systemic Initiative projects reported improved student achievement in math in 81% of the 4,187 schools and improved student performance in science in 86% of the 2,474 schools using the same assessments for the last 3 years.

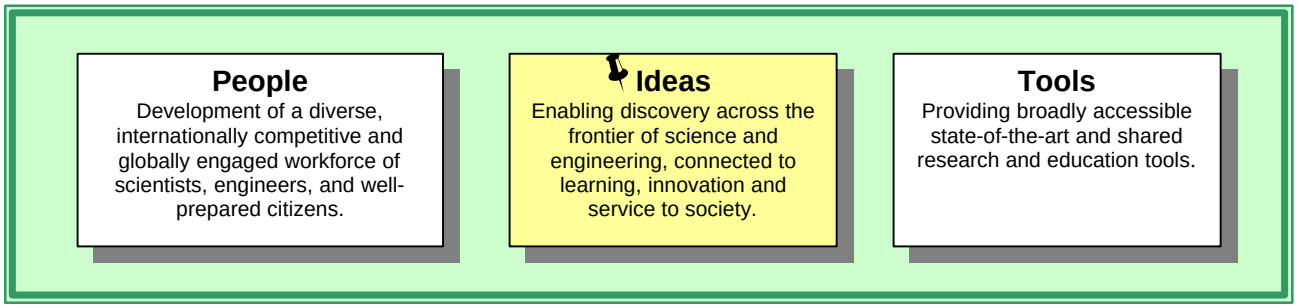
FY 2001 Result: The curriculum, instructional workforce, and improved achievement in science components of the goal were successful. However, less than 80% of schools met the goal of improved student achievement in mathematics. Forty-seven Systemic Initiative projects implemented mathematics and science standards-based curriculum in 89% of the participating schools and provided professional

development for more than 226,900 teachers. The Systemic Initiative projects reported improved student achievement in math in 74% of the 6,255 schools and improved student performance in science in 80% of the 4,082 schools using the same assessments for the last 3 years.

IMPLICATIONS FOR THE FY 2002 PERFORMANCE PLAN: This goal will be maintained in FY 2002.

NSF STRATEGIC OUTCOME GOALS

B. IDEAS



STRATEGIC OUTCOME GOAL III-2: Enabling "discovery across the frontier of science and engineering, connected to learning, innovation, and service to society."

✓ Goal Achieved

NSF invests in ideas to provide a deep and broad fundamental science and engineering knowledge base. Investments in ideas support cutting-edge research that yields new and important discoveries and promote the development of new knowledge and techniques within and across traditional boundaries. The results of NSF-funded research and education 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.

Our performance is successful when, *in the aggregate*, results reported in the period demonstrate significant achievement in the majority (four of six) of the following indicators:

- Discoveries that expand the frontiers of science, engineering, or technology;
- Discoveries that contribute to the fundamental knowledge base;
- Leadership in fostering newly developing or emerging areas;
- Connections between discoveries and their use in service to society;
- Connections between discovery and learning or innovation; and
- Partnerships that enable the flow of ideas among the academic, public or private sectors.

RESULT: NSF achieved this goal. External experts provided examples of significant achievement in reports they developed during FY 2002 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 2003 PERFORMANCE PLAN: This goal will be continued in FY 2003.

IDEAS: 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 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/od/gpra/reports/final_report_1107.doc

"The Ideas Portfolio met the Committee's standards for significant achievement for all indicators based on considerations of quality, relevance and balance. A detailed discussion of the specific indicators for this portfolio can be found in Appendix II of this report. However, it should be noted that not every project provided as an example for an indicator met these standards. This is due in part to inadequate descriptions.

Review of a cross-section of NSF-supported research accomplishments drawn broadly from NSF's directorates points to a substantial number of important contributions to fundamental knowledge in existing fields of science, discoveries that have expanded the frontiers of science, engineering or technology, and leadership in fostering newly developing and emerging areas. Especially striking in the case of newly developing and emerging scientific areas is the prevalence of multi-disciplinary (and multi-institutional) approaches. This pattern appears most frequently at the interfaces between and among the life sciences, physical sciences and engineering. It is less evident in the social sciences.

Many of these research achievements under the Ideas category contribute to the attainment of performance objectives under People and Tools goals."

INDICATOR 1: Discoveries that expand the frontiers of science, engineering, or technology.

RESULT: *Demonstrated significant achievement.*

"The 67 retrospective accomplishments and 30 prospective examples reviewed ranged from fundamental studies of gravitational waves and the testing of Einstein's Theory of General Relativity to discovery of the oldest rocks on Earth and chiral catalysts with the ability to synthesize specific enantiomorphs (i.e., left or right-hand versions) of a molecule. Some of the projects described in these nuggets involve basic science, with no apparent long-term societal payoff, whereas others involve applied science and engineering with high potential for almost immediate societal impact. An example of the former is a nugget describing the discovery of extrasolar planets. An example the latter is synthesis of self-tightening bolts from smart piezoelectric and shape memory materials. Another class of nuggets involves social science research ranging from group decision making to the connections between war and technological/scientific innovations in the civilian arena, such as the development of pesticides following World War II. There were also several social science projects that dealt with public attitudes in the U.S. following the terrorist attacks of 9/11/01."

"55 of the 67 retrospective I-1 accomplishments and all 30 of the prospective I-1 examples reviewed under the Indicator "Discoveries that expand the frontiers of science, engineering, or technology" were judged to be of high quality, although it was difficult to fully understand many of the projects based on the information reported in the nuggets. The twelve I-1 retrospective accomplishments that were judged to be of less than satisfactory quality suffered from poor explanations of why the studies were significant

in a broader context of science, engineering, or technology. The projects that were judged to be outstanding (12 in the retrospective category and seven in the prospective category) covered many disciplines and represent cutting-edge research that is pushing the frontiers of science, engineering, and technology."

INDICATOR 2: Discoveries that contribute to the fundamental knowledge base.

RESULT: *Demonstrated significant achievement.*

" The Indicator 2 (I2) portfolio contains many nuggets that describe work of very high quality and with large impact on the fundamental knowledge base. The nuggets selected are representative of this high quality work."

"The I2 portfolio describes projects that cut across the entire NSF. These projects fit well into the mission of the Foundation, have impact on the PIT Goals, and are relevant to the Foundation's stakeholders."

"The work represented in the I2 portfolio will likely have large and positive impact on the fields represented. In some cases, that impact will go beyond the disciplinary area of the PI."

INDICATOR 3: Leadership in fostering newly developing or emerging areas.

RESULT: *Demonstrated significant achievement.*

"Selection based on documentation within vignettes of external recognition by scientific community, bridging of two or more scientific fields/techniques, and breadth of applicabiity of potential solutions. Several vignettes presented under prospective impacts are excellent examples of risky, interdisciplinary research; indeed, they are better examples than several of those listed under that emphasis area."

"Uneven quality of documentation dominates ability to assess overall quality of NSF portfolio. However, a sufficient number of vignettes exist to point to attainment of NSF goal of supporting research at the frontiers of science, making contributions to fundamantal knowledge in existing fields, and most impressively, being at the cutting edge of research in forging new scientific fields. Other vignettes are more indicative of good but "normal" science. For still other vignettes, accounts are either too brief to permit assessment or raise questions about why they were showcased by program managers."

"Few proposals are explicitly listed as risky, making assessment of this criterion difficult."

INDICATOR 4: Connections between discoveries and their use in service to society.

RESULT: *Demonstrated significant achievement.*

"Uneveness in the nugget descriptions does not allow a general quality and intellectual merit determination for the I4 portfolio as a whole."

"Of the approximately 100 nuggets investigated in the I4 portfolio, about 30% were considered to be of significant service to society. Considering that NSF has struggled in the past to be directly relevant in its research projects, this is a good score."

"Because of the nature of this portfolio, (service to society), it does not contain much high risk research."

"The 30% of the I4 portfolio considered to have a high service to society rating has a relatively broad impact, by definition."

INDICATOR 5: Connections between discovery and learning or innovation.

RESULT: *Demonstrated significant achievement.*

"We interpreted indicator I5 with regard to connecting discovery to innovation as reflecting transition of scientific results into useful technology and with regard to connecting discovery to learning as reflecting research related directly to the learning process."

"The sample portfolio consisted of 25 "nuggets" (accomplishments). These covered a broad spectrum of projects including research in the life, physical, and geological sciences, research on education and educational outcomes, and the development of a number of tools. A subset that was selected as representing our interpretation of indicator I5 were of high quality and easily passed the "significant achievement" test."

"It was difficult to assess why some of the projects were selected for inclusion as nuggets."

INDICATOR 6: Partnerships that enable the flow of ideas among the academic, public or private sectors.

RESULT: *Demonstrated significant achievement.*

"Of the partnership nuggets reviewed almost all were impressive in terms of the quality, importance, and innovativeness of the research. The breadth of the research was particularly impressive, including challenging problems in areas of material science, climate modeling, nanoscience, speech recognition, gene silencing, earthquake prediction, genome sequencing, and evolutionary history. The nuggets presented above illustrate the breadth and quality of the research and other partnering activities."

"As with the retrospective nuggets, NSF has an impressive array of important projects of considerable merit. The prospective nuggets described are representative of the quality and intellectual merit of the prospective portfolio."

Area of Emphasis 1: Biocomplexity in the Environment.

"The biocomplexity area funds a very wide-ranging set of projects. Many of them are very likely to lead to significant discoveries. Essentially all of the nuggets in the portfolios – both prospective and retrospective – describe interesting interdisciplinary projects.

If there is one difficulty in the assessment, it is in the rather amorphous understanding of what is meant by *complexity*. In some instances it appears to be used only to justify inclusion under the umbrella of the initiative."

Area of Emphasis 2: Information Technology Research

"The quality, creativity, importance and breadth of the projects in the Information Technology Research (ITR) Emphasis Area are impressive. Projects show important investments in high end computing (allowing researchers to tackle problems previously considered too complex), research at the frontiers and interfaces of scientific areas, and data handling (gathering, storing, analyzing, sharing and displaying information). The nuggets provide specific examples for each of these."

"The portfolio demonstrates a good balance of risky, high potential benefit projects versus less risky research. Many of the projects are multidisciplinary, particularly the research at the interface of biology and physics."

Area of Emphasis 3: Nanoscale Science and Engineering

"Most of these research projects have great potential for future impact in many fields, ranging from medicine to computing to chemical sensing of environmental pollutants."

Area of Emphasis 4: Interdisciplinary Mathematics

"This is a new emphasis area with a small portfolio. There were only eight nuggets to review, however, the breadth and quality of these projects were impressive. This activity is part of NSF's increasingly critical role in advancing interdisciplinary science and will grow in the future. The nuggets illustrate the application of cutting-edge mathematics to problems in the physical, climate, and social sciences. The eight projects reviewed have the potential for important impacts and support NSF's goal of "enabling discovery across the frontier of science" as well as advancing NSF's role in establishing multidisciplinary communities to address the challenging problems of the future."

Area of Emphasis 5: Balance of IDEAS Portfolio, including projects that are innovative, risky, or multidisciplinary

"Interdisciplinary projects exhibit high (absolute and relative) degrees of riskiness and innovativeness**.**"

Comments from FY 2002 NSF Committee of Visitors

- "The Program Directors' use of exploratory awards is a flexibility that allows deserving concepts to be more fully developed. It is a catalyst to and protection of high risk/high yield. The majority of awards in the portfolio of the [BES/ENG] Division are multidisciplinary; a balance that is deemed fully appropriate. Successful proposals in cluster solicitations are uniformly innovative. Variable degrees of innovation are observed in the unsolicited proposals. High risk investment is evident even for well defined areas such as the regulation of transcription and translation in defining phenotype …"

- "Few multidisciplinary projects were noted in the jackets…The technical risk of funded projects is generally low, although other elements of risk are apparent. Some risk is inherent in distributing a significant number of projects in less developed countries. The level of innovation in the funded projects is appropriate."

- "Program has an appropriate balance of high risk proposals, especially in ATI (Advanced Technologies and Instrumentation) and the use of Small Grants for Exploratory Research (SGER)."

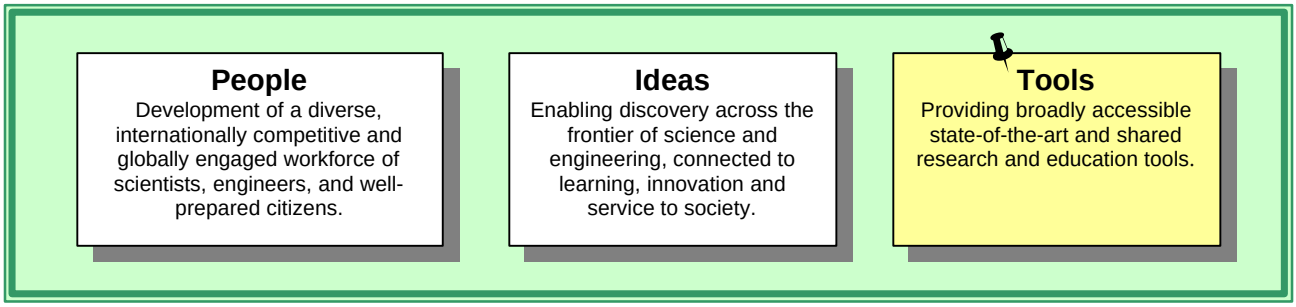
- "The current funding plan involving planning grants and Phase I proposals is an appropriate means to help increase the number of proposals that will meet the major goals of the IERI program. Most of the proposals funded under this initiative are multidisciplinary. … While the proportion of applications that directly address questions about scaling up has so far been limited, it is anticipated given the beginning nature of the field, that future proposals addressing these questions will involve innovative ideas and designs."

- "The number of proposals in this class [high risk] seems appropriate but certainly remains at a level where further expansion could be supported. The use of the division reserve to promote the funding of programs in this class is appropriate and supported by the COV. … In some important areas of research … there exists a diversity of theories as to the mechanism. Reviews in such cases can be quite divergent and the judgment of the PD is critical … The innovation exhibited in the proposals was remarkably high. This is a distinction that seems to show no age preference. The portfolio is very healthy in this regard. The growing representation of interdisciplinary and collaborative programs of research are notable and warrant recognition."

- "EHR employed an independent contractor to perform an independent analysis of awards made under the ROLE program. Sixty-seven jackets were reviewed. Seventeen percent of the proposals were determined to be high risk; 26% multidisciplinary, and 2% innovative."

NSF STRATEGIC OUTCOME GOALS

C. TOOLS



STRATEGIC OUTCOME GOAL III-3: Providing "broadly accessible, state-of-the-art and shared research and education tools."

✓ Goal Achieved

NSF invests in tools to provide widely accessible, up-to-date science and engineering infrastructure. This strategic outcome supports the parts of NSF's mission directed at (1) programs to strengthen scientific and engineering research potential and (2) an information base on science and engineering appropriate for development of national and international policy.

As emerging research opportunities increasingly involve phenomena at or beyond the limits of our measurement capabilities, many research areas can only be studied and problems solved through the use of new generations of powerful tools. NSF investments provide state-of-the-art tools for research and education, such as instrumentation and equipment, multi-user facilities, digital libraries, research resources, accelerators, telescopes, research vessels and aircraft and earthquake simulators. In addition, resources support large surveys and databases as well as computation and computing infrastructures for all fields of science and engineering research and education. Support includes funding for construction, upgrade, operations, and maintenance of facilities, and for personnel to assist scientists and engineers in conducting research and education at the facilities.

Our performance is successful when, *in the aggregate*, results reported in the period demonstrate significant achievement in the majority (four of six) of the following indicators:

- Provision of facilities, databases or other infrastructure that enable discoveries or enhance productivity by NSF research or education communities;
- Provision of broadly accessible facilities, databases or other infrastructure that are widely shared by NSF research or education communities;
- Partnerships, e.g., with other federal agencies, national laboratories, or other nations, to support and enable development of large facilities and infrastructure projects;
- Use of the Internet to make SMET information available to the NSF research or education communities;
- Development, management, or utilization of very large data sets and information-bases; and
- Development of information and policy analyses that contribute to the effective use of science and engineering resources.

RESULT: Reports prepared by external experts during FY 2002 GPRA reporting provided assessments and retrospective examples of NSF-supported projects that document significant achievement. 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 2003 PERFORMANCE PLAN: This goal will be continued in FY 2003.

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/od/gpra/reports/final_report_1107.doc

"The Committee concluded that NSF made significant achievements across the entire set of Tools indicators and emphasis areas. The Committee selected a number of illustrative achievements and examples to support this finding. A detailed discussion of specific indicators can be found in Appendix III. NSF support for Tools allowed wider and more effective dissemination of data and materials, enhanced the abilities of scientists, engineers, and educators to do their work, and increasingly expanded access to and availability of resources. In several cases (particularly astronomy and earth sciences), NSF-supported resources directly impacted the rate of progress for the discipline as a whole. Examples of new Tools that support the Committee's finding include: supercomputing resources, new large-scale experimental instruments, national-scale digital libraries, and repositories of data from unique sources ranging from radio astronomy to real-time oceanographic data from widely separated locations."

INDICATOR 1: Provision of facilities, databases or other infrastructure that enable discoveries or enhance productivity by NSF research or education communities.

RESULT: *Demonstrated significant achievement.*

"NSF supports facilities/infrastructure thoughout its portfolio, including as part of awards to individual investigators and through large community-based resources such as telescopes, ships, global sensor networks, accelerators, high-performance computers and community databases. By their very nature, these large facilites are beyond the ability of single institutions or PIs to support. Thus they truly *enable discoveries* that would not be possible without the level of support and coordination that NSF can provide. At the same time, they *enhance productivity* through economies of scale and prioirty setting by the user community. NSF investments in these areas tend to be long term. While incremental improvements and activities can be highlighted on an annual basis, the continued existence and on-going operation of these tools in itself is an important part of the NSF portfolio.

Clusters of these types of resources can be found in the nuggets for this indicator; e.g.,

Arctic/Antarctic support
Radio/Optical telescope
SBS databases
Nanotechnology facilities
Earth/Ocean observational systems."

INDICATOR 2: Provision of broadly accessible facilities, databases or other infrastructure that are widely shared by NSF research or education communities.

RESULT: *Demonstrated significant achievement.*

"The NSF'S investments in projects addressing this indicator of the Tools goal have provided returns that significantly advance the achievement of the overall goal. This is especially true of the astronomical sciences; indeed, education, research, and a well-trained scientific workforce would be inconceivable in the absence of the broadly accessible facilities, databases and shared infrastructure for which the NSF provides the major support. Other efforts are making advances in the assessment of children's attention available to large numbers of researchers. Such efforts hold considerable promise for improving our understanding of the teaching/learning process, and could grow to have a major influence on programs of the newly- established NSF Centers for Learning and Teaching. The activities addressing this indicator are balanced with respect to facilities and databases."

INDICATOR 3: Partnerships, e.g., with other federal agencies, national laboratories, or other nations, to support and enable development of large facilities and infrastructure projects.

RESULT: *Demonstrated significant achievement.*

"The NSF has demonstrated significant achievement in implementing partnerships with other federal agencies, national laboratories, and other nations to support and enable the development of large facilities and infrastructure projects. These partnerships include several other federal agencies; examples include: Department of Energy, EPA, NASA, NIH, NOAA, Library of Congress, Air Force, and the Navy. Examples of partnerships with national laboratories include Argonne National Laboratory, Brookhaven National Laboratory, and Los Alamos National Laboratory. Limited examples of partnerships with other nations were provided."

INDICATOR 4: Use of the Internet to make SMET information available to the NSF research or education communities.

RESULT: *Demonstrated significant achievement.*

"The NSF portfolio of investments in Tools as evidenced by achievements with respect to this indicator is characterized by activities that cover a broad spectrum of environments from software for the processing neutron scattering to the exchange of information on teaching practices among a community of almost 2000 K-12 teachers. There is a richness of diverse educational environments and subject matter, including non-doctoral institutions, non-profit research institutes and consortia. The subject matter includes seismic information, imaging and visualization programs, information on global change with highly developed conferencing capabilities, information on deep seafloor expeditions that are available to students via the internet, and information via the internet on income dynamics resulting in the transfer of qs many as 10,000 datasets annually. The return on the NSF's investments in this area is truly remarkable."

INDICATOR 5: Development, management, or utilization of very large data sets and information-bases.

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

"The restrospective project nuggets showed investigation in key areas which are either pressing problems today, or are examples of problems that will increase in the future. Important issues in the retrospective examples included security and privacy issues, as well as large data sets with increased accessibility, utility and properties such as distributed, real-time and international sources. Examples illustrated the importance of the development, management and utilization of real-time and real-time sensory data, including that from human sources such as music, or related to human senses such as the olfactory. Among the more important data management issues covered were issues of data privacy and security, in both statistical and image databases. Among the more important data utilization issues were making large data sets (often gathered over long periods of time) available to scientists and the public through new dissemination channels."

INDICATOR 6: Development, management, or utilization of very large data sets and information-bases.

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

"The retrospective projects described studies whiich provide information which contributes to policy analyses and the effective use of science and engineering resources. Significant retrospective achievements have been made in producing information in establishing rules to control Radio frequencies, in studying how landscape fragmentation affects demographic and genetic parameters ofselected migratory birds, in preparing science and engineering indicator reports that can be used by Congress and the President, and in developing an electronic publishing technique which protects authorship rights."

Area of Emphasis 1: Investments in Major Research Equipment and Facilities Construction (MREFC)

"The NSF has made significant investments in Major Research Equipment and Facilities Construction (MREFC). These investments have tremendous potential for future impacts by providing broadly accessible, state-of-the-art and shared research and education tools. These ongoing and prospective investments in research equipment and facilities are an excellent start and can easily be expanded to support additional equipment and facilities."

Areas of Emphasis 2: Continuing investments in Major Research Instrumentation (MRI)

"The MRI program is a highly effective mechanism to respond to instrumentation needs that lie between the individual project level and the Major Research Equipment account. Since these projects are usually proposed and evaluated with close linkages to established research programs, they tend to be strongly research driven (as opposed to technology innovation). Cost sharing with research directorates help to provide leverage and ensure prioritization by the user community. NSF has made outstanding selections of prospective projects that promises to create centers, develop modern instrumentation and assemble systems with existing instrumentation that will have high impact on science and engineering education."

Areas of Emphasis 3: Continuing investments in the National SMETE Digital Library (NSDL)

"As with science data sets and science database management techniques, this is an increasingly important area for NSF support. Many scientists use an unstructured search with a web search engine to augment their work (e.g., Google or NEC's Citeseer), yet the data, and the methodologies for locating and accessing them, are incomplete. The projects funded have been focused on leveraging the digital library medium to enhance knowledge bases in important disciplines. There was a notable and desirable flavor of collaboration to many of these projects. There were a notable number of women PIs and Co-PIs."