



College of Charleston

66 George Street
Charleston, South Carolina 29424-0001

September 12, 2003

The Honorable Rita Colwell, Ph.D.
Director
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Colwell:

We are pleased to submit the report of the Advisory Committee for GPRA Performance Assessment (AC/GPA) for 2003. It was the unanimous judgment of the Committee that for the retrospective portfolio NSF demonstrated significant achievement for all indicators in the Ideas and Tools outcome goals and for the three indicators (P1, P2, and P3) associated with the first People annual performance goal. For indicators P4 and P5 associated with the second annual performance goal for People, the Committee saw evidence of future achievement. But because these indicators focus narrowly on the Mathematics and Science Partnerships program, which is very new, there was insufficient information to reach a judgment on significant achievement for these indicators.

The Committee also concluded that the three outcome goals are mutually reinforcing and synergistic. They represent an integrated framework that combines research and education. Thus, the three goals should always be considered as an integrated whole when assessing performance.

The Committee very much appreciated the efforts made by NSF staff to respond positively to our previous suggestions on the process. We urge, however, that NSF continue to review this process and perhaps consider an approach that involves a more significant component of "self study." Such a process, with the Committee continuing to serve in the role of an independent assessment team, could serve as a worthwhile internal mechanism for NSF to evaluate its own performance against its strategic goals and performance plans. Let me emphasize that the Committee continues to believe that an independent assessment of NSF's performance by experts other than those among the NSF staff is valuable.

This report represents the collective work of a large group of individuals, the members of the Committee, all of whom worked with a level of commitment and diligence that we have rarely encountered. Each of them made significant contributions to the report and collectively we believe they have again set a new standard for the work of advisory committees. It was an honor and a privilege for us to lead this effort. In addition, many members of the NSF staff were instrumental in enabling our work and we are truly grateful for their assistance.

We would be happy to talk with you or others about any aspect of this report. We hope it will be helpful to NSF as it completes its Accountability Report.

Sincerely,

Carolyn W. Meyers

Carolyn W. Meyers, Ph.D.
Provost and Vice Chancellor for
Academic Affairs
North Carolina A&T University

Norine E. Noonan

Norine E. Noonan, Ph.D.
Dean
School of Science and Mathematics

**REPORT OF THE ADVISORY COMMITTEE FOR
GPRA PERFORMANCE ASSESSMENT**

Submitted: September 12, 2003
Norine E. Noonan, Ph.D.
Chairman

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**National Science Foundation
FY 2003 Advisory Committee for GPRA Performance Assessment
(AC/GPA)**

Dr. Norine E. Noonan (Chair)
Dean, School of Sciences and Mathematics
College of Charleston

Dr. Carolyn W. Meyers (Vice-Chair)
Provost and Vice Chancellor for Academic Affairs
Professor, College of Engineering
North Carolina A&T State University

Dr. Richard A. Aló
Executive Director, Center for Computational Science
and Advanced Distributed Simulation
Professor, Dept. of Computer and Mathematical Sciences
University of Houston-Downtown

Dr. Burt D. Ensley
President and CEO
Phytotech, Inc.
Sedona, AZ 86336

Dr. B.J. Evans
Professor, Department of Chemistry
University of Michigan

Dr. Irwin Feller
Senior Visiting Scientist,
American Association for the Advancement of Science (AAAS)
Professor Emeritus of Economics
Pennsylvania State University

Dr. S. James Gates, Jr.
John S. Toll Professor of Physics
University of Maryland

Dr. David J. Hofmann (did not attend the meeting but provided written assessments)
Director, Climate Monitoring and Diagnostics Laboratory (CMDL)
National Oceanic and Atmospheric Administration (NOAA)

Dr. Elizabeth J. Kelly
Technical Staff Member, Statistical Sciences
Los Alamos National Laboratory

Dr. George L. Liggins
President and CEO
Bacton Assay Systems, Inc.

Dr. Louis Martin-Vega
Dean, College of Engineering
University of South Florida

Dr. Michael A. McRobbie
Vice President for Information Technology
and CIO
Indiana University at Bloomington

Dr. Alfred L. Moyé
Consultant
Hewlett-Packard Company

Dr. Gloria Rogers
Vice President for Institutional Research, Planning
and Assessment
Rose-Hulman Institute of Technology

Dr. David W. Simpson
President
The IRIS Consortium

Dr. Jonathan M. Smith
Professor, Department of Computer and Information Science
University of Pennsylvania

Dr. Thomas N. Taylor (did not attend the meeting)
Distinguished Professor
Department of Ecology and Evolutionary Biology
University of Kansas

Dr. Timothy W. Tong
Dean, School of Engineering & Applied Science
The George Washington University

Mr. James H. Yeck
U.S. Large Hadron Collider Project Manager
U.S. Department of Energy
Fermi National Accelerator Laboratory

Dr. Vera Zdravkovich
Vice President for Instruction
Prince George's Community College

A. OVERALL SUMMARY AND CONCLUSIONS

The Advisory Committee for Government Performance and Results Act (GPRA) Performance Assessment (AC/GPA) met on June 24-26, 2003 at NSF Headquarters in Arlington, VA to consider the activities and achievements of NSF relative to its GPRA performance goals for FY 2003. The charge to the Committee asked that it provide:

- An assessment of results for indicators associated with the three strategic outcome goals of People, Ideas and Tools.
- Comments on the quality and relevance of retrospective and prospective award portfolios.
- Comments on investment portfolios for potential future impact.

The Committee reviewed voluminous materials from NSF's retrospective and prospective award portfolios both prior to and during the meeting. In addition, the Committee had electronic access to all annual and final project reports and an extensive set of reports from various Committees of Visitors. The group conducted extensive discussions on all of the indicators and emphasis areas for NSF's three strategic outcome goals. **It was the unanimous judgment of the Committee that for the retrospective portfolio, NSF demonstrated significant achievement for all indicators in the Ideas and Tools annual performance goals and for the three indicators (P1, P2, and P3) associated with the first People annual performance goal. For indicators P4 and P5 associated with the second annual performance goal for People, the Committee saw evidence of future achievement, but because the indicators focus narrowly on the Mathematics and Science Partnerships program, which is very new, there was insufficient information to reach a judgment on significant achievement for these indicators.**

The Committee also concluded that the three outcome goals are mutually reinforcing and synergistic. They represent an integrated framework that will, when taken together, combine research and education. The extensive documentation also underscores the interdependence of NSF's three strategic goals. Discovery at the frontiers of knowledge is both supportive of and dependent on progress in effectively linking research and education, the development of new instrumentation, facilities and data acquisition and analysis, and the education and training of a national workforce highly qualified in science, engineering and mathematics. Thus, the three goals should always be considered as an integrated whole when assessing performance.

NSF's retrospective portfolio of accomplishments for the People outcome goal continues to be impressive in its strength, breadth and diversity. The portfolio contains important examples of education and research programs as well as programs that integrate research and education. All are designed to enable students, educators and researchers to explore the challenges of science, technology, engineering and mathematics (STEM) related fields. NSF accomplishments in the Ideas outcome goal have advanced the frontiers of discovery and hold considerable promise for expanding fundamental understanding in many areas of science and engineering and for addressing

important societal concerns. NSF accomplishments in the Tools outcome goal have expanded access to and availability of data and materials, and have enabled the capacity for discovery by scientists, engineers and educators. Taken together, the portfolios demonstrate excellence, relevance and leadership. The nation's investment in these activities is well made.

This report is arranged as follows:

- An overarching review of the entire retrospective portfolio (that encompasses People, Ideas and Tools.)
- An overarching review of the entire prospective portfolio.
- Information on the approach and methodologies used by the Committee.
- Discussion chapter on People outcome goal.
- Discussion chapter on Ideas outcome goal.
- Discussion chapter on Tools outcome goal.
- Comments on the ACGPA process.
- Appendices with detailed information on indicators for outcome goals.

Finally, the Committee would like to extend its deep gratitude to the NSF GPRA staff, particularly Bernard McDonald, Craig Robinson, Steve Mahaney, Eve Barak, Betty Wong, Bret Mervis, Maury Pully, Joan Miller, Maxine Hynson, Morris Aizenman, Marty Rubenstein, Pamela Green, Gregory Martin and Nazaneen Karimi for their excellent support. Our work (and this report) would simply not have been possible without their dedication and careful attention to both the “big picture” and the smallest details and their grace under extreme time pressure. We want to especially thank Peggy Gartner for developing the collection/display selection software for the accomplishments/examples. We would also like to again thank Karen Geary and her Information Technology team for their cheerful and competent technical support at the meeting for sometimes-frustrated Committee members, and we thank the NSF program staff, and NSF's senior leadership for their commitment to this effort.

INDICATORS FOR NSF STRATEGIC OUTCOME GOALS

Strategic Outcome	FY 2003 Annual Performance Goal	AC/GPA Assessment
<p>People Strategic Outcome</p> <p>Outcome Goal III-1: Developing “a diverse, internationally competitive and globally-engaged workforce of scientists, engineers, and well-prepared citizens.”</p>	<p><u>Performance Goal III-1a:</u></p> <ul style="list-style-type: none"> • Development of well-prepared researchers, educators or students whose participation in NSF activities provides experiences that enable them to explore frontiers or challenges of the future; • Contributions to development of a diverse workforce through participation of underrepresented groups (women, underrepresented minorities, persons with disabilities) in NSF activities; • Development or implementation of other notable approaches or new paradigms that promote progress toward the People outcome goal. <p><u>Performance Goal III-1b: NSF will significantly enhance the quality of K-12 mathematics and science education available to all students in Math and Science Partnership Schools.</u></p> <ul style="list-style-type: none"> • Evidence in the award portfolio of the infrastructure to support high quality programs addressing issues related to teacher workforce capacity, including preservice education and inservice professional development of math and science teachers as well as alternative routes into the profession (e.g., scientists and engineers becoming teachers); • Evidence within Partnership school systems of the infrastructure needed to improve mathematics and science education and to measure improvement, i.e., the adoption of appropriate assessments of student achievement, as well as the initiation of the collection of achievement data that can be disaggregated by ethnicity, socioeconomic status, gender, etc. 	<ul style="list-style-type: none"> • Demonstrated significant achievement. • Demonstrated significant achievement. • Demonstrated significant achievement. • Program was initiated in 2002 and is new. Not enough information to make a judgment about significant achievement in 2003. • Program was initiated in 2002 and is new. Not enough information to make a judgment about significant achievement in 2003.

<p>Ideas Strategic Outcome</p> <p>Outcome Goal III-2: Enabling “discovery across the frontier of science and engineering, connected to learning, innovation and service to society.”</p>	<p><u>Performance Goal III-2:</u></p> <ul style="list-style-type: none"> • Discoveries that expand the frontiers of science, engineering, or technology; • Connections between discoveries and their use in service to society; • Partnerships that enable the flow of ideas among the academic, public or private sectors. • Leadership in fostering newly developing or emerging areas; 	<ul style="list-style-type: none"> • Demonstrated significant achievement. • Demonstrated significant achievement. • Demonstrated significant achievement. • Demonstrated significant achievement.
<p>Strategic Outcome</p>	<p>FY 2003 Annual Performance Goal</p>	<p>ACGPA Assessment</p>
<p>Tools Strategic Outcome</p> <p>Outcome Goal III-3: Providing “broadly accessible, state-of-the-art and shared research and education tools.”</p>	<p><u>Performance Goal III-3:</u></p> <ul style="list-style-type: none"> • Development or provision of tools that enables discoveries or enhances productivity of NSF research or education communities; • Partnerships, with local, state or federal agencies, national laboratories, industry, or other nations to support and enable development of large facilities and other infrastructure; • Development or implementation of other notable approaches or new paradigms that promote progress toward the TOOLS outcome goal. 	<ul style="list-style-type: none"> • Demonstrated significant achievement. • Demonstrated significant achievement. • Demonstrated significant achievement.

B. APPROACH AND METHODOLOGIES USED BY THE AC/GPA

The Advisory Committee for GPRA Performance Assessment (AC/GPA) is comprised of twenty members representing the nation's scientific and engineering research and education communities in the public and private sectors. About half the AC/GPA membership is drawn from existing Directorate or Office Advisory Committees and about half are "at-large" members. The membership reflects a broad cross section of talent, expertise, and experiences. Its purpose is to provide expert advice and recommendations to NSF regarding the Foundation's performance under the Government Performance and Results Act (GPRA) of 1993. It is expected that the findings and recommendations of the Committee will provide valuable input to NSF's GPRA Performance and Accountability Report for FY 2003.

The focus of the AC/GPA is on the activities and results associated with the indicators and emphasis areas of NSF's three strategic outcome goals: PEOPLE, IDEAS, and TOOLS. The principal work of the Committee was conducted as a "committee of the whole." Three subcommittees (PEOPLE, IDEAS, and TOOLS) composed of AC/GPA members provided the detailed analysis of the results associated with each indicator and emphasis area. All of the subcommittees reported their analyses, findings and conclusions to the full AC/GPA for its discussion. Within the subcommittees, each AC/GPA member was assigned specific indicators to review on the basis of a large volume of retrospective accomplishments and prospective examples provided by the NSF staff. It should be noted that these accomplishments and examples were provided in a "bottoms up" fashion by the Directorates and were not subject to any selective process by NSF GPRA staff prior to the Committee's review. Thus, although illustrative of the range of NSF's activities, these accomplishments/ examples did not constitute a strictly statistically "representative" sample (i.e., every program did not necessarily provide accomplishments/examples and the total numbers were not weighted in any way). In addition, this year the entire process of prospective assessment was affected by the extreme lateness of Congressional action on NSF's FY 2003 budget.

Nevertheless, it is the Committee's view that taken as a whole, the extensive data made available to the Committee constituted a reasonable judgmental sample to support its conclusions about NSF's performance. The Committee, however, believes that more can and should be done by NSF to provide a more rigorous and consistent selection across all the Directorates of the accomplishments and examples and to provide more thorough documentation of the process by which accomplishments and examples were generated. An improved and more systematic process to create a portfolio of program accomplishments would facilitate the Committee's work as well as that of NSF in preparing for future assessments.

Although materials were available to Committee members two months before the meeting, the Committee as a whole did the majority of its work in about 2.5 days. This is a relatively brief time to assess the performance of a large and diverse portfolio of

research investment. The subcommittees (and the full Committee) had a large amount of material available for its work, for example:

- A large database of retrospective accomplishments and prospective examples.
- Committee of Visitors reports (limited to those that had been received, presented to and discussed by the relevant directorate Advisory Committee).
- A database containing the universe of annual and final project reports.
- NSF's Strategic Plan and Annual Performance Plans.
- NSF's Budget Requests to Congress.
- Relevant National Science Board reports.
- Information from NSF's Budget Internet Information System (e.g., award summaries, agency funding history).
- Information from NSF's management information systems.

NSF provided the Committee with a secure web site where all of this information was accessible and much of it was "hot-linked" to the source documentation. Committee members were able to review materials prior to the meeting and NSF staff made available any information that was requested by Committee members or subcommittees. Even though it was well organized, the sheer volume of this information created some methodological challenges. For example, it was difficult to systematize the use of accomplishments/examples since these represented almost entirely qualitative assessments. A more thorough discussion of this issue can be found in the section on Comments on the Process and the Committee's Work.

The subcommittees consolidated their respective preliminary analyses, indicator-by-indicator, into a draft report for discussion of and consideration by the full AC/GPA committee. Similarly, overall portfolio assessments from each working group were shared with the entire AC/GPA for discussion. Comments and amendments from any member of the full Committee were then included in these outcome goal "chapters" and subsequently in the final draft report. The final draft was then distributed electronically to each committee member for review and comment. The final report is informed by the resulting input and is presented here.

The Committee believes that modifications to this process might be worth exploring in future years. For example, NSF might want to consider a broad involvement of its staff and leadership in creating a more analytical self-study that would form the starting point for the Committee's work. This issue is discussed in more depth in the section on Comments on the Process.

C. RETROSPECTIVE PORTFOLIO OF NSF OUTCOMES/RESULTS REPORTED IN FY 2003

Provide Foundation-level comments on:

- **The overall quality of the retrospective portfolio of outcomes and outputs reported in FY 2003.**
- **The relevance of the retrospective portfolio of outcomes and outputs reported in FY 2003 to the needs of the Nation, of S&T fields and program “customers.”**
- **Innovative, risky and multi-disciplinary research and education in NSF’s retrospective portfolio of outcomes and results reported in FY 2003.**

In constructing its assessment of the overall quality of the retrospective portfolio of outcomes and outputs, the Committee relied on an extensive database of NSF-supported projects provided by NSF program staff, individual project reports, reports from external Committees of Visitors (COVs) and other information. In addition, individual members of the Committee possess deep familiarity with various aspects of NSF’s portfolio, thus, the Committee was able to rely, in part, on its own expertise and independent assessment.

The Committee concluded that the quality of the retrospective portfolio was high in all three outcome goals. The breadth, depth, and diversity of the collective set of projects funded by NSF not only represent significant achievement, but also represent a spectrum of research modes. NSF supports individual investigators, multiple investigator teams, large centers, as well as shared facilities, databases and other infrastructure vital to support the national research enterprise.

The Committee must note that in the People outcome goal, however, the second annual performance goal is focused too narrowly, in the Committee’s view, only on Math and Science Partnership Schools. This is a new program (actually a re-packaging of a number of related K-12 efforts) that only made its first round of awards in the Fall of 2002. While the Committee saw evidence of the potential of this program to have tangible and important outcomes in the future, it is far too early to have a robust retrospective portfolio on which to base a judgment of “significant achievement” in FY 2003. This report reflects that fact, as noted above.

The Committee also discussed the need for NSF to assume an even stronger leadership role in the nation’s efforts to improve pre-college mathematics and science education. The Committee recognizes and appreciates the difficulty of measuring the specific impact of NSF’s investments in K-12 STEM education, but strongly urges that such assessment efforts be stepped up further. The record of research accomplishment in the retrospective portfolio includes much that is directly connected to existing (and future) societal concerns. In fact, the amount and diversity of impacts flowing from NSF-supported research is quite striking, spanning topics such as earthquakes, wildfire

management, avalanche prediction, global climate change, speech and language, even preservation of historical artifacts.

Thus, NSF is making significant contributions toward the achievement of important national goals and is also serving the needs of its constituents in the scientific community as well as the broader needs of science, engineering and education as human endeavors.

The Committee wants to reiterate that in large part the power of the outcome goals lies in their synergy. The notion of mutually supportive and reinforcing goals aimed at the three major elements of progress – people, ideas and tools – has stood the test of time. Discoveries at the frontiers of knowledge is both supportive of and dependent on progress in effectively linking education and research, the development of new instrumentation, facilities, and tools for data acquisition and analysis, and the education and training of a national workforce highly qualified in science, engineering and mathematics. This synergy is clearly reflected in the extensive documentation of accomplishments and other supporting information. There were numerous instances where an accomplishment cited as supporting the PEOPLE outcome goal could just as easily have supported the IDEAS outcome goal and vice versa. The same is true for many of the accomplishments in the TOOLS portfolio. The Committee felt that it was important to continue to make this point, as it did in its FY 2002 report

The Committee was unanimous in its assessment that the high quality, relevance and performance of the NSF portfolio (both retrospective and prospective) 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. We urge NSF and its external stakeholders, both within and outside the Federal government, to continue to support the competitive merit review process and to resist forces (e.g., Congressionally-directed appropriations) that would distort this process with adverse impact on future performance.

With regard to innovative, “risky”, and multi-disciplinary research and education, the Committee saw evidence of accomplishment as well as continuing leadership by NSF in this area. It is reasonable to accept that some fraction of the research that NSF funds will not lead to new paradigms or transform our thinking. No obvious formula exists to guide NSF as to the fraction of the portfolio that should be multi-disciplinary (defined as research or education activities that cross traditional discipline boundaries and create synergistic interactions at those junctions). This type of research could, in many cases, be considered “high risk” since it often involves competing data, methods, theories and experimental approaches. The Committee notes that the COVs are explicitly asked to examine this issue and in most cases have concluded that the balance is appropriate. In addition, program managers continue to encourage high-risk proposals through the Small Grants for Exploratory Research ([SGER](#)) mechanism. NSF's Small Business Innovation Research Program ([SBIR/STTR](#)) is also recognized as a leader in the federal government in supporting novel research and technology with potentially high payoff. Lastly, the Committee notes that the encouraging trend continues for cross-disciplinary programs wherein multiple NSF directorates collaborate to fund a single research activity (e.g.,

mathematics and biology, environmental research, cyberinfrastructure). While this can serve as a proxy for investment in high-risk, multi-disciplinary research and education, more definitive analyses of these investments is needed.

D. ASSESSMENT OF FY 2003 NSF INVESTMENTS: THE PROSPECTIVE PORTFOLIO

Provide Foundation-level comments on:

- **The relevance of NSF’s prospective portfolio to the needs of the Nation, of S&T fields, and of program “customers”.**
- **The external planning and prioritization activities that guided prospective portfolio development.**
- **Innovative, risky and multi-disciplinary research and education in NSF’s prospective portfolio of awards.**

NSF’s prospective portfolio continues to exhibit desirable characteristics: strong relevance to larger national goals, potential for substantial future achievement and impact, and participation of stakeholders (e.g., the scientific and engineering communities) in the planning process for new initiatives. The Committee believes that the prospective portfolio is well positioned to support NSF’s strategic outcome goals in the future. The Committee notes, however, that the nature of these investments is such that it is simply not possible to assess now what all of the positive benefits of this portfolio will be or when they will occur.

The Committee heard about the internal and external planning and prioritization efforts that NSF undertakes in developing its overall future investment strategies. It heard about two specific examples: the [Atacama Large Millimeter Array](#) (a large astronomical facility) and [Environmental Research and Education](#) (a broad-based, cross-directorate research initiative). The Committee also reviewed other reports (e.g., [Science and Engineering Infrastructure for the 21st Century](#) (National Science Board),” a report on cyberinfrastructure, “[Greater Expectations: A New Vision for Learning as a Nation Goes to College](#)”). In addition, the Committee heard about the annual internal budget planning and prioritization process that NSF undertakes. It is clear that in many areas, NSF uses the recommendations of these reports and those from other external groups such as the National Research Council, and the Nuclear Science Advisory Committee (joint with the Department of Energy) to develop its annual and long-range investment strategies. Most of these reports, as well as the many science-driven workshops supported by NSF, are targeted at specific large projects, disciplines, or cross-disciplinary initiatives. But together they provide NSF with a reasonable basis for its internal planning and prioritization activities that are then reflected in the agency’s annual budget requests.

E. OUTCOME GOAL: PEOPLE

PEOPLE OUTCOME GOAL: FOUNDATION-LEVEL SUMMARY

- **Provide an overall assessment of progress toward attainment of this outcome goal.**

The NSF Strategic Outcome Goal for People is: *Developing a “diverse, internationally competitive and globally engaged workforce of scientists, engineers, and well-prepared citizens.”* NSF is to be commended for its many programs at all levels that strive to provide the nation with a diverse and competitive science and engineering workforce. While there remains room for improvement, NSF’s efforts to engage administrators, faculty, and students at all levels in this strategic outcome goal have produced significant results. Progress has been made toward the attainment of both annual performance goals. The Committee judges that NSF has made significant achievement in three of the five indicators for this outcome goal (P1, P2, P3 associated with the first annual performance goal). For indicators P4 and P5 (associated with the second annual performance goal), both of which are focused exclusively on the very new Math and Science Partnership program (MSP), while there was evidence of future achievement, the Committee did not have enough information to reach a conclusion about NSF’s performance.

The Committee recognizes the accomplishments of many excellent NSF-supported programs and initiatives. However, we recommend that NSF strengthen its assessment of the broader, long-range impacts. This is particularly important for programs affecting K-12 students. In recommending that assessment be strengthened, the Committee recognizes the complexity of determining the impact of NSF’s programs relative to programs supported by other agencies. However, it is important for NSF to increase its focus on trying to more clearly determine the impact of NSF support on success and achievement gaps of Science, Technology, Engineering and Mathematics (STEM) students in NSF-supported schools and/or school systems.

The Committee also recommends that NSF continue to strengthen linkages between K-12 teacher development and the research programs NSF supports. Involvement of teachers in research has been shown to improve their understanding of concepts and content knowledge, and it can also enhance interest and motivation. It is reasonable to expect that this improvement will have a positive impact on student achievement.

The Committee also brings the following issues to the attention of NSF for its consideration:

- The second annual performance goal focusing only on Math and Science Partnership schools is too narrow. This program is too new for the Committee to have been able to review it adequately, and it

represents only a thin slice in the total NSF commitment to, and investment, in K-12 STEM education.

- The Committee believes that NSF needs to have an even stronger leadership role in the Nation's efforts to improve science and math education and the performance of K-12 students – much as it has played and continues to play in STEM higher education.

The "PEOPLE" retrospective portfolio continues to be impressive in its diversity, breadth and impact. The projects are drawn from a wide variety of programs with significant achievements in most areas of the portfolio. Examples range from very large investments targeted at achieving significant systemic and/or international impact to single investigator supplements that impact very small groups of individuals. Program participants range from pre-school teachers to graduate faculty and students through activities such as pre- and in-service teacher training programs, research experiences for students and K-12 teachers, and internship and professional development workshops and training programs. Many of the examples in the retrospective portfolio are very relevant to the national need to develop a diverse workforce through participation of underrepresented groups in NSF activities.

The portfolio of prospective examples provides documentation that indicates the potential for substantial future impact in the People goal. A recently funded project for a workshop on Undergraduate Research Centers explores how a research experience can be brought to a far larger and more diverse group of undergraduates at an earlier stage of their academic program. In contrast to the retrospective portfolio, where the population of persons with disabilities was not addressed at all, new awards reflect the attention now being paid to this under-represented population.

Promising efforts also address the issue of parent engagement. A good example is the expansion of the ASTRO site program to include families of all backgrounds.

The Committee also notes examples that illustrate the significant impact of NSF research on the development of a diverse and internationally competitive workforce in the NSF-wide critical thrust areas of Nanoscale Science and Engineering, Information Technology Research, Biocomplexity in the Environment and other high priority research programs. The Committee believes that NSF is laying a solid foundation for the development of well-prepared researchers, educators or students whose participation in NSF activities will enable them to explore the frontiers and intellectual challenges of the future.

The first annual performance goal for FY 2003 states: *“NSF’s performance for the People Strategic Outcome is successful when, in the aggregate, results reported in the period demonstrate significant achievement in the majority of the following three indicators.”*

- Under the first indicator, “Development of well-prepared researchers, educators or students whose participation in NSF activities provides experiences that enable them to explore frontiers or challenges of the future,” NSF is funding a host of programs that provide a path to achievements for a diverse, internationally competitive, and globally engaged workforce of scientists, engineers and well-prepared citizens. Examples of programs that support this indicator are: Research Experiences for Undergraduates and Research Experiences for Teachers. While there were no accomplishments in the database for the Minority Institutions Infrastructure Grants program, the Committee notes that this program also supports this indicator. In particular, a very successful activity that supports the development of a diverse Science, Technology, Engineering and Mathematics (STEM) workforce has been the Research Experiences for Undergraduates (REU) program that NSF has now institutionalized across the Foundation through REU sites, REU supplements, collaborative Research in Undergraduate Institutions programs, and other mechanisms. Innovative implementation of the Research Experiences for Undergraduates (REU) concept has provided excitement both within and among institutions that has led, in some cases, to groundbreaking research results prompted by the involvement of undergraduate students.
- Projects and accomplishments under the second indicator, “*Contributions to development of a diverse workforce through participation of underrepresented groups in NSF activities*” are impressive and contribute significantly toward the attainment of the overall PEOPLE goal. For example, the Louis Stokes Alliances for Minority Participation (LSAMP) continues to represent one of the most important programs, contributing to significant achievement for this indicator. The Committee notes that it also strongly supports the first indicator for the PEOPLE goal. The point here is that LSAMP participation now extends to over 30 alliances representing over 400 individual institutions. The impact extends to over 206,000 underrepresented minority students. The original goal of LSAMP was to increase the number of underrepresented minorities receiving undergraduate degrees in science, engineering, and mathematics. While significant progress has been made in achieving this goal, LSAMP has recently been expanded to include a strong emphasis on graduate studies as well. Just in the last three years over 80 LSAMP students have completed the doctorate in science, engineering or mathematics and are working in their fields. An additional 20 LSAMP students are currently enrolled in Ph.D. programs. While the numbers are still small, this program has had a significant positive impact on the number of doctoral degrees received by underrepresented minorities in the U.S. and thus contributes materially to this indicator. Nearly every NSF program has

the opportunity to impact this indicator. The LSAMP cited above is a good example of this “cross fertilization.” In light of this, the Committee believes that NSF has both the obligation and the opportunity to use a varied armamentarium of programmatic initiatives (from all Directorates and programs) to achieve this indicator. While the portfolio supporting this indicator is strong, the Foundation will be challenged in the future to sustain current programs that have this indicator as their primary focus and to enhance all the programs in its PEOPLE portfolio.

- Under the third indicator, “ *Development or implementation of other notable approaches or new paradigms that promote progress toward the PEOPLE Outcome Goal,*” the NSF portfolio contains important examples of education and research programs that are designed to enable students, educators and researchers to explore the challenges of science, technology, engineering and mathematics and related fields. Overall there is a balance of programs supporting learning and exploration at the K-12 level; teacher and faculty development activities; curriculum development and dissemination activities for K-12 and college classrooms; mass media, print and web-based public awareness activities; and activities to encourage women and underrepresented minorities to develop interest and pursue STEM careers. For example, in the area of multi-lingual speech translation and communication, research has produced a system that enables users to connect with a "commercial" service provider that speaks a different language and receive detailed information via a live video-conferencing channel in which speech translation is embedded.

Mentoring activities continue to be an important part of this portfolio. There are examples of workshops and training grants aimed at developing women and minority faculty leaders. Nonetheless, there is a continuing need to increase the participation of women and underrepresented minorities in many areas of science and engineering. Other studies in this portfolio highlight issues such as the impact of departmental practices in attrition rates of undergraduate women in computing majors as well trends indicating that women are finding non-traditional pathways into the IT workforce.

The second FY 2003 annual performance goal under PEOPLE state “*NSF will significantly enhance the quality of K-12 mathematics and science education available to all students in Math and Science Partnership schools.*” The Committee notes that this is a very narrowly focused goal that does not take into consideration all the past and existing partnerships that have been established within a plethora of other, older initiatives. The specific Math and Science Partnership (MSP) program is new. Its first round of awards was made late in 2002.

The Committee looked more broadly at the panoply of programs aimed at pre-college math and science education. It could be stated that while the time and money

invested in the improvement of K-12 education by many federal agencies over the last ten years have been significant, the national Report Card continues to reflect low performance by K-12 students in math and science. NSF Programs such as the Urban Systemic Initiatives, the Science and Math Collaborative program, the State Systemic Initiatives, and the others including the current Math and Science Partnerships appear to have had some effect in reducing the achievement gap. However, in the face of the small amount of student progress as measured by the National Report Card, there is more that must be done.

- **Provide an overall assessment of whether there appear to be particularly promising effort likely to enable achievement of NSF's desired outcomes in the future.**

There are several planned initiatives that are leading the way as particularly promising efforts that will likely have salient impacts on the achievement of this strategic outcome goal in the future. These include new directions in cyberinfrastructure development and design, new challenges for chemistry and chemical engineering and new challenges in biology and microbiology. The latter is a very high risk initiative but a fundamental one necessary to be taken to meet the Grand Challenge in Microbiology.

For example, in 2003 planning was completed by the Advisory Committee on Cyberinfrastructure. The report (see <http://www.cise.nsf.gov/news/cybr/cybr.htm>) includes an overarching recommendation that “*the National Science Foundation should establish and lead a large-scale, interagency, and internationally coordinated Advanced Cyberinfrastructure Program (ACP) to create, deploy, and apply cyberinfrastructure in ways that radically empower all scientific and engineering research and allied education.*” NSF is building on this report and its compelling vision to move in the recommended direction. Several planning activities are underway including re-focusing Partnerships for Advanced Computational Infrastructure and Terascale investments to become central computing resources for cyberinfrastructure.

NSF is also supporting a number of reports to assist in guiding planning for engineering research and education activities. These include:

- [*Beyond the Molecular Frontier, Challenges for Chemistry and Chemical Engineering*](#), a recent report of the National Research Council (NRC) that outlines thirteen grand challenges for the 21st century
- A World Technology Evaluation Center [*evaluation of worldwide biosensing activities \(state of the art and future trends\)*](#), in cooperation with NIH, NASA and the Department of Defense.
- The development of a research agenda by the NRC for the [*Network for Earthquake Engineering Simulation Research*](#)

In FY2003 NSF initiated a new activity: [*Frontiers in Integrative Biological Research*](#), whose goal is to encourage researchers to address previously intractable

biological questions by providing the resources and time required for multi-disciplinary teams to tackle them. Any biological question can be addressed and risk taking is explicitly encouraged and used as a review criterion.

- **For each Area of Investment in Emerging Opportunity¹ associated with the PEOPLE goal, comment on whether there appear to be particularly promising efforts likely to enable achievement of NSF's desired outcomes in the future.**

- ***Math and Science Partnership***

The Math and Science Partnership (MSP) initiative focuses on building capacity for the nation, enacting a strategy to improve achievement in mathematics, measuring teachers' content knowledge in mathematics, reaching all K-12 students, and scaling up while focusing on teaching and learning. This program, initiated in 2002, holds the promise of a positive impact on K-12 students' achievements in math and science. Promising efforts include a design study by TERC ([0233472](#)) that will create a MSP Network (MSP-NET), a web-based interactive electronic community for MSP grantees. Another example of a partnership with potential long-term positive impact is the University of Michigan project ([0233456](#)) that promises to develop and validate measures of teachers' knowledge of mathematics. A strategy for supporting MSPs in the use of these measures will be developed. A good example of an MSP project ([0227124](#), [0227521](#), [0227028](#)) addressing achievement gap and student success is the partnership of Black Hills State University, Technology and Innovations in Education (TIE) of the Black Hills Special Services Cooperative, and the Rapid City School District aimed at improving achievement in mathematics for all students in Rapid City Schools with a particular goal of reducing the achievement gap between Native American and non-Native American students. The project intends to improve and sustain both in-service and pre-service teachers in mathematics. In addition, it seeks to improve mathematics preparation of high school students.

[0237653](#)

Funded under: PEOPLE
Award Title: Building from the Research: Envisioning Quality Science Assessments
PI Name: Pasquale DeVito
Institution Name: National Academy of Sciences

[0233472](#)

Funded under: PEOPLE
Award Title: MSP-Network: A Technical Assistance Design Project
PI Name: Joni Falk
Institution Name: TERC Inc

¹ Math and Science Partnership; Centers for Learning and Teaching; Graduate Student Stipends: -- Increasing stipends for GRF, IGERT and GK-12.

[0233382](#)

Funded under: PEOPLE
Award Title: Building Evaluation Capacity of STEM Projects
PI Name: Blaine Worthen
Institution Name: Utah State University

[0227057](#)

Funded under: PEOPLE
Award Title: Vermont Mathematics Partnership
PI Name: Kenneth Gross
Institution Name: The Vermont Institutes

[0226972](#)

Funded under: PEOPLE
Award Title: Revitalizing Algebra
PI Name: Diane Resek
Institution Name: San Francisco State University

[0233456](#)

Funded under: PEOPLE
Award Title: Design, Validation and Dissemination of Measures of Content Knowledge for Teaching Mathematics
PI Name: Heather Hill
Institution Name: University of Michigan Ann Arbor

• ***Graduate Student Stipends: Increasing stipends for GRF, IGERT, and GK-12.***

NSF is to be commended for implementing a plan to increase the stipend for Graduate Research Fellows (GRF). From 1999 to 2003, the annual stipend increased from \$15,000 to \$27,500, and is scheduled to reach \$30,000 in 2004. The increases have resulted in more high quality applicants that want to pursue graduate education and research. Examples of outstanding applicants that were selected as a GRF can be found in the following awards ([0202745](#), [0234631](#), [0202750](#)). Similar increases in applicants have also been reported in the GK-12 program ([0139126](#), [0086426](#)).

This area addresses increasing graduate student stipends in Graduate Research Fellow, Integrative Graduate Education and Research Traineeship, (IGERT) and Graduate Teaching Fellows in K-12 Education (GK-12) programs. The increase in stipend played a role in attracting the second largest applicant pool in GRF history and has also had a positive effect on the GK-12 program.

The 900 GRF awardees represent future leaders in the science and engineering enterprise of the United States. Successful GRFs are involved in cutting edge research: Lincoln Chandler, a graduate student in Mathematics, is exploring projects that link optimization theory to the field of education. As a member of the Operations Research Center at the Massachusetts Institute of Technology, he is interested in moving his research into one or more of the

following areas: analysis of modeling approaches for managing learning content, development of “best fit” pathways for navigating courses in the presence of imperfect data from the student user, and the development of optimal sharing strategies for large volumes of learning content. Kimberly TallBear is conducting research on the use of DNA analysis in determining Native American tribe citizenship or group belonging. Her work, in the History of Consciousness program at the University of California – Santa Cruz, is multidisciplinary, considering the issue from the perspectives of population genetics, human heredity, cultural and physical anthropology, archaeology and race, and the history of race and related categories in science. Successful GRF programs are being established at Yale University in biodiversity ([0231832](#)), and for women at Georgia Tech ([0202757](#)) and at Utah State ([0237094](#)). The increase in the stipend from \$21,500 to \$27,500 has also had a positive effect on several GK-12 projects.

IGERT is a program focused on integrating research and education at the graduate level. The program has made significant advances in promoting the development of the STEM professoriate and work force. Of the many successes, two are noted: [Computational Analysis of Social and Organizational Systems \(9972762\)](#); and, [Cross-Disciplinary Training in the Neural Basis of Cognition \(9987588\)](#).

The Graduate Teaching Fellows in K-12 program (GK-12) is focused on enhancing the instructional workforce. About four years old, the program seeks to interest and involve the graduate students it supports in teaching and pedagogy at the pre-college level, with the goal of strengthening curriculum and instruction in K-12 schools and giving graduate students the opportunity to be mentored in pedagogy by experienced teachers. In 2001-2, the 56 GK-12 projects supported 514 graduate students and 205 advanced undergraduates. (Some examples are [Research-Based Resources Support Rigorous Professional Development For Teachers of Mathematics \(9731424, 9911679\)](#); and [GK-12 Fellows Program At NC State \(9979583\)](#)).

A second example is detailed in [Academic Excellence for Urban Students: Their Accomplishments in Science and Mathematics \(9874322\)](#), an evaluative study of 22 of the Urban Systemic Initiative districts funded between 1994-1999. The study concluded that leveraging resources, providing strong leadership, and creating effective partnerships were critical to improvement of student performance, although gains occurred between 7-10 years.

[9972762](#)

Funded under: PEOPLE
Award Title: IGERT Formal Proposal: Multidisciplinary Training Program in Computational Analysis of Social and Organizational Systems
PI Name: Kathleen Carley
Institution Name: Carnegie-Mellon University

[9987588](#)

Funded under: PEOPLE
Award Title: IGERT Full Proposal: Innovative Cross-Disciplinary Training in Neuroscience and Computation
PI Name: David Touretzky
Institution Name: Carnegie-Mellon University

[9979583](#)

Funded under: PEOPLE
Award Title: Collaborative Proposal: Duke-NCSU Teaching Fellows in Elementary Education Program
PI Name: Laura Bottomley
Institution Name: North Carolina State University

[0202749](#)

Funded under: PEOPLE
Award Title: Graduate Research Fellowship Program
PI Name: Maria Burnatowska-Hledin
Institution Name: University of California-Berkeley

[0086420](#)

Funded under: PEOPLE
Award Title: Georgia Tech Student and Teacher Enhancement Partnership (STEP) Program
PI Name: Donna Llewellyn
Institution Name: Georgia Tech Research Corporation - GA Institute of Technology

- ***Centers for Learning and Teaching***

Three new **Centers for Learning and Teaching** were added to NSF's portfolio in FY 2003. All three are collaborations among multiple institutions, schools and education associations. *The Center for Learning and Teaching with a Focus on Research for Developing Instructional Materials* ([0227557](#)) is creating new leaders for curriculum development and will support 30 Ph.D. and 30 postdoctoral students, prepare 30 master teachers and provide professional development to 400 science teachers. *The Center for Proficiency in Teaching Mathematics* ([0227586](#)) will examine the mathematical knowledge teachers should have to teach effectively and will use that knowledge to strengthen pre- and in-service education programs. *The Center for Inquiry in Science Learning and Teaching* ([0227619](#)) will study the effect of varying types of collaboration on professional development; develop tools for assessing technical backgrounds of educators; and create suggestions for professional development roadmaps for educators.

Since all of the Centers are in their initial stages of development, it is not possible to determine their impact. However, they all have the potential of leading to tangible and important outcomes in the future.

[9731424](#)

Funded under: PEOPLE
Award Title: Reconceptualizing Mathematics Teaching and Learning Through Professional Development
PI Name: Genevieve Hanlon
Institution Name: Community School District Two

[9911679](#)

Funded under: PEOPLE
Award Title: Preparing Elementary Teachers to Help Students Shift from Arithmetic to Algebraic Reasoning
PI Name: Thomas Carpenter
Institution Name: University of Wisconsin-Madison

[9987227](#)

Funded under: PEOPLE
Award Title: Computer Science, Engineering, and Mathematics Scholarships Program
PI Name: Christie Gilliland
Institution Name: Green River Community College

[9731643](#)

Funded under: IDEAS
Award Title: ERC: Research Center for the Engineering of Living Tissues
PI Name: Robert Nerem
Institution Name: Georgia Tech Research Corporation - GA Institute of Technology

[0089989](#)

Funded under: PEOPLE
Award Title: ITW: Retaining Women in Computer Science Programs: The Impact of Pair-Programming
PI Name: Linda Werner
Institution Name: University of California-Santa Cruz

[9528813](#)

Funded under: IDEAS
Award Title: Environmentally Benign Semiconductor Manufacturing
PI Name: Farhang Shadman
Institution Name: University of Arizona

[9816227](#)

Funded under: PEOPLE
Award Title: Houston Urban Learning Initiatives in a Networked Community
PI Name: Kathryn Stripling
Institution Name: Houston Independent School Dist

- **For each Area of Emphasis for GPRA Reporting² associated with the PEOPLE goal, comment on whether NSF has demonstrated significant achievement within the portfolio of activities associated with these areas.**

NSF is investing in a broad range of activities that aim to improve the performance of preK-12 students in mathematics and science. There are awards focused on issues relating to preK-12, undergraduate and graduate students. There are also awards that support center type activities as well as activities that are designed to encourage participation from underrepresented groups. The Committee provides some outcome accomplishments that highlight NSF's investment in these specific areas.

- ***PreK-12 Education***

Under an integrated program for middle school science teachers ([0202923](#)), a new middle school curriculum was developed from collaboration among university faculty, community college faculty, science content teachers and science education teachers. This project also contributed to preparation of middle school science teachers.

The Houston Urban Systemic Initiative ([9816227](#)) reported rather impressive results in improving K-12 student performance. For example, it was reported that the Texas Assessment Academic Skills mathematics test for all students indicated an eight percentage point increase at the 3rd grade level and a three percentage point increase at the 5th and 8th grade levels.

- ***Undergraduate Education***

Over the years, an increasing number of undergraduate students have been involved in research through NSF funding. Principal investigators could seek supplemental funding under the Research Experiences for Undergraduates (REU) program to engage undergraduate students in their projects. About ten years ago, NSF institutionalized this activity by funding REU sites where undergraduate students from different universities were brought together for a period of time to gain research experience (e.g. [0138640](#), [0139527](#)).

NSF funds projects that have created unique opportunities for undergraduate students. For instance, an award ([0097066](#)) to the Association of American State Geologists made it possible for undergraduate students to conduct

² PreK-12 Education, e.g., Systemic Reform; Undergraduate Education, e.g., REU; Graduate and Professional Development, e.g., IGERT, GK-12, CAREER; Centers for Learning and Teaching (CLT); Broadening Participation, e.g., Partnerships for Innovation, Programs that serve underrepresented groups (for example, women, underrepresented minorities, or persons with disabilities).

fieldwork with professionals outside of the university setting and helped to prepare them for a successful career in earth sciences.

- ***Graduate and Professional Development***

There are various forms of NSF support for graduate students. Some of the support is used to fund collaborative research. An IGERT award ([9987588](#)) was used to fund a parallel multi-unit neurophysiological recording lab. The supported students did rotations in this laboratory and brought their background from different disciplines to bear on the project. An IGERT award ([9870633](#)) in the neuroscience and computational/physical science areas brought together researchers and graduate students from eight departments to work on projects that transcend disciplines.

- ***Centers for Learning and Teaching***

The retrospective examples all represent innovative, primarily multi-institutional efforts that appear to be highly promising in terms of their impact on the development and enhancement of diversity in STEM education and research. Since they are all still in the initial stages of their five-year awards, the full significance of their impacts is yet to be determined.

The **Diversity in Mathematics Education (DiME) Center** is a collaborative effort of the University of Wisconsin, UC-Berkeley, and UCLA focusing on research that addresses the dual issue of student diversity and the learning of algebra ([0119732](#)).

The two other centers are particularly innovative and appealing. *The Center for Informal Learning and Schools (CILS)* ([0119787](#)) offers the only PhD program in the United States, and only one of three programs in the world, designed to prepare educational professionals for careers in informal settings such as science centers, museums and aquariums. The *Appalachian Collaborative Center for Learning Assessment and Instruction in Mathematics (ACCLAIM)* ([0119679](#)) aims to build mathematics capability and expertise and improve the quality of mathematics teaching in the Appalachian region through the development of collaborative networks and innovative delivery systems.

[0119732](#)

Funded under: PEOPLE
Award Title: Diversity in Mathematics Education: Building Infrastructure for Learning and Teaching Mathematics with Understanding
PI Name: Walter Secada
Institution Name: University of Wisconsin-Madison

[0083336](#)

Funded under: PEOPLE
Award Title: Center for Applications of Information Technology in the Teaching and Learning of Science
PI Name: Richard Ewing
Institution Name: Texas Engineering Experiment Station

[0119787](#)

Funded under: PEOPLE
Award Title: Center for Informal Learning and Schools
PI Name: Robert Semper
Institution Name: Exploratorium

[0119679](#)

Funded under: PEOPLE
Award Title: CLT: Appalachian Collaborative Center for Learning, Assessment and Instruction in Mathematics
PI Name: Vena Long
Institution Name: University of Tennessee Knoxville

[0227557](#)

Funded under: PEOPLE
Award Title: Center for Learning and Teaching with a Focus on Research for Developing Instructional Materials in Science
PI Name: Jo Ellen Roseman
Institution Name: American Association For Advancement Science

[0227586](#)

Funded under: PEOPLE
Award Title: Center for Proficiency in Teaching Mathematics
PI Name: Patricia Wilson
Institution Name: University of Georgia Research Foundation Inc

[0227619](#)

Funded under: PEOPLE
Award Title: St. Louis Center for Inquiry in Science Teaching & Learning
PI Name: Christine Klein
Institution Name: Washington University

[0227558](#)

Funded under: PEOPLE
Award Title: Center for the Advancement of Engineering Education
PI Name: Cynthia Atman
Institution Name: University of Washington

[0227592](#)

Funded under: PEOPLE
Award Title: Center for the Integration of Research, Teaching, and Learning
PI Name: Robert Mathieu
Institution Name: University of Wisconsin-Madison

- ***Broadening Participation***

Many NSF funded activities serve to promote science and engineering to a wide audience. For example, a TV mini-series called “The Shape of Life” ([9814957](#)) presented the story of evolution of the animal kingdom and was

broadcast nationwide by PBS. In the production of the program, media professionals collaborated with researchers from different universities. A summative evaluation indicated that the program was well received by many viewers. Another example ([9731483](#)) involved career enhancement of high school teachers through improvement of mathematics curriculum in the Greater Philadelphia area. There are also examples of NSF providing support for teacher education ([9731424](#), [9911679](#)). These projects resulted in two new mathematics textbooks that employed research-based teaching strategies.

F. OUTCOME GOAL: IDEAS

IDEAS OUTCOME GOAL: FOUNDATION-LEVEL SUMMARY

- **Provide an overall assessment of progress toward attainment of this outcome goal.**

Based on a review of extensive documentation of NSF supported research projects provided by the Committees of Visitors, the database of accomplishments assembled by NSF project reports, and NSF budget and other information, the Committee concludes that NSF has demonstrated significant achievement in all four indicators for the IDEAS Strategic Outcome Goal, *enabling “discovery across the frontier of science and engineering, connected to learning, innovation, and service to society.”* The Committee reached this conclusion based on the evaluation of the results related to the indicators (see Appendix) as well as an evaluation of priority and emphasis areas.

The results reported in this section span NSF's research directorates and are indicative of both breadth and depth in the scientific and educational communities supported by NSF. The Committee was very excited about and impressed with the research outcomes. This research holds considerable promise for expanding fundamental understanding of the origins of our universe and of humankind's long-term survivability and well-being. NSF researchers were awarded several notable prizes for their research, including a Nobel Prize for Bose-Einstein condensate work, the prestigious Japan prize for complex systems, chaos and fractals, and the Panofsky prize for experimental particle physics. In addition, NSF funded 80 percent of mathematicians who received 2003 Sloan fellowships. Such notable achievements by these researchers reflect the caliber and importance of the research that NSF supports.

Equally striking, the record of accomplishments includes considerable research directly connected to important societal concerns, including earthquake behavior, wildfire management, avalanche prediction, global climate change and its effects on society, novel insecticides from spider neurotoxins that are not toxic to humans, brain function, and preservation of historical artifacts. This research has both a currency of application and the promise of new and deeper understanding of the fundamental science that can yield future societal benefit.

The Committee is impressed with NSF's continuing endeavor to foster integration of research and education. Also noteworthy is NSF's continuing objective and recent accomplishments in increasing the participation of underrepresented groups in the sciences. These outcomes include recruiting students and providing mentoring to guide and encourage them to become active members of the scientific community. There are several excellent examples of these efforts in the Mathematical Sciences Priority Area.

The record of performance for FY 2003 is noteworthy as well for the extent of collaborations between U.S. academic researchers and a large and diverse set of partners in the public and private sectors in the U.S. as well as scientists in other countries.

NSF's achievements represent a spectrum of research modes, including single investigator projects and larger, multi-disciplinary projects involving researchers at a single institution or researchers at several institutions. It is clear from the Committee's review that NSF is actively building a research capacity to address problems at the interface of scientific disciplines and even the emergence of new fields at the frontiers of science. Examples of these efforts include initiatives in Biocomplexity in the Environment, Mathematical Sciences, and Human and Social Dynamics.

- **Provide an overall assessment of whether there appear to be particularly promising efforts likely to enable achievement of NSF's desired outcomes in the future**

The Committee believes that the NSF priority areas are excellent examples of particularly promising research investments to (1) enable discovery that expands the frontiers of science, (2) develop multidisciplinary research capacity, (3) address problems of importance to society and (4) foster new and emerging research areas. The priority areas are described below and include Biocomplexity in the Environment, and Human and Social Dynamics. The priority areas recognize that historical disciplinary boundaries are breaking down as researchers find that they must integrate theory, data, experimental approaches, and methods across several disciplines to address challenging research questions at the frontiers of knowledge. Many of these questions also have high societal relevance. These activities build the capacity, both in terms of investigators and infrastructure, to conduct leading edge, collaborative, multidisciplinary research.

The Climate Change Research Initiative (CCRI) is another example of a new effort of considerable importance to society with challenging research questions. This leading-edge research holds promise for reducing the uncertainties related to human-induced climate change and facilitating full use of scientific information in policy and decision-making

Investments in core research and education also illustrate new areas of great potential. These areas include cosmology, quantum science and technology, cyber infrastructure, and high performance computing. The new Science of Learning Centers

Program represents an important effort to expand the knowledge about learning. NSF will support large-scale, multidisciplinary, long-term Centers that will extend the frontiers of knowledge on learning and create the intellectual, organizational, and physical infrastructure needed for the long-term advancement of learning research.

- **For each Area of Investment in Emerging Opportunity³ associated with the IDEAS goal, comment on whether there appear to be particularly promising efforts likely to enable achievement of NSF's desired outcomes in the future.**
- **For each Area of Emphasis for GPRA Reporting⁴ associated with the IDEAS goal, comment on whether NSF has demonstrated significant achievement within the portfolio of activities associated with these areas.**

The Committee has chosen to combine the sections for this outcome goal as the areas below contain both examples of particularly promising efforts and demonstrations of significant achievement.

Priority Areas

- ***Biocomplexity in the Environment.***

The outcomes from this priority area demonstrate particularly promising efforts in expanding the frontiers of science, engineering and technology. Projects are highly multidisciplinary, collaborative and contain significant educational components. Examples include studies in gene regulation linked to the external environment ([0083704](#)), remote sensing in aqueous environments ([0136671](#)), and studies of the interactions between urban development and riparian ecosystems ([0120022](#)). The NSF supports new interdisciplinary research combining broad areas of biology and chemistry, engineering, mathematics, computational and information technology, and social and material sciences. The NSF's new project portfolio includes the application of novel analytical and sensing methods ([0216305](#)) and instruments and large-scale studies of atmospheric and aquatic environments ([0234980](#)).

³ Priority Areas: Biocomplexity in the Environment, Information Technology Research, Nanoscale Science and Engineering, Mathematical Sciences, Social, Behavioral and Economic Sciences; Core Research and Education Activities; Science of Learning Centers; Climate Change Research Initiative.

⁴ Balance of portfolio, including projects that are innovative, high risk, or multidisciplinary activities; Current Priority Areas: Biocomplexity in the Environment, Information Technology Research, Nanoscale Science and Engineering; Former Priority Areas: Life and Earth's Environment, Information Technology for the 21st Century, Knowledge and Distributed Intelligence; Core research and education activities; Centers, e.g. STCs, ERCs, MRSECs; EPSCoR.

[0083704](#)

Funded under: IDEAS
Award Title: Biocomplexity: From Gene Expression to Morphology and Multicellular Organization in Dictyostelium
PI Name: Herbert Levine
Institution Name: University of California-San Diego

[0136671](#)

Funded under: IDEAS
Award Title: Deployable in Situ Electrochemical Analyzer (ISEA) for Remote and Automatic Analysis of O₂, H₂S and Sulfur Species in Hydrothermal Vent Environments
PI Name: George Luther
Institution Name: University of Delaware

[0120022](#)

Funded under: IDEAS
Award Title: BE/CNH: Interactions of Riparian Pattern, Policy, and Biocomplexity in Coupled Human/Riverine Systems
PI Name: Stanley Gregory
Institution Name: Oregon State University

[0216305](#)

Funded under: IDEAS
Award Title: BE/IDEA: An Autonomous Genosensor for Environmental Water Quality Monitoring
PI Name: John Paul
Institution Name: University of South Florida

[0234980](#)

Funded under: TOOLS
Award Title: Webs on the Web: Internet Database, Analysis, and Visualization of Ecological Networks
PI Name: Neo Martinez
Institution Name: San Francisco State University

- ***Information Technology Research (ITR)***

The ITR program provides extremely effective interdisciplinary research funding with an information technology basis, with a wide and compelling variety of examples. The first example focuses on epidemiological studies enabled by information technology, the second on interfaces and interactions for “systems” constructed of biological and electronic components, and the third on novel physical methods for implementing functionality required in modern security protocols ([0205116](#), [0113679](#), [0122419](#)).

These examples demonstrate the important interactions between fields stimulated by collaborative research in information technology. Each of these projects represents an excellent emerging opportunity and is likely to have significant impact.

Concerns exist that some proposals, although representing excellent science, may be more appropriately placed in discipline-specific existing NSF programs rather than ITR that is intended for multidisciplinary approaches.

Examples might include research that is either conventional IT, or appears (at least on the surface) to have an inadequate IT component.

[0205116](#)

Funded under: PEOPLE
Award Title: ITR: Special Focus on Computer Science and Epidemiology
PI Name: Fred Roberts
Institution Name: Rutgers University New Brunswick

[0113679](#)

Funded under: PEOPLE
Award Title: ITR/Comp Bio: The Computer Science of Biologically Embedded Systems
PI Name: Michael Black
Institution Name: Brown University

[0122419](#)

Funded under: IDEAS
Award Title: ITR/SY: Center for Bits and Atoms
PI Name: Neil Gershenfeld
Institution Name: Massachusetts Institute of Technology

- ***Nanoscale Science and Engineering***

Within the confines of areas of investment and emerging opportunities for the field of Nanoscale Science and Engineering, the NSF has sought to strategically invest in research programs that provide a foundation for new technology. The range of conceivable applications is extremely broad, including improvement in pollution control, new medicine delivery modalities, ultra-miniature electronic devices, unique optical material required for photonics applications as well as the impact of these nascent technologies on society in general: ([0000485](#)) catalysis for alternate fuels, ([0210656](#)) cells as biological nanomachines, ([0102950](#)) electronic devices at the atomic and molecular scale: structure and charge, ([0122419](#)) left-handed materials, and ([0210552](#)) philosophical and social dimensions of nanoscale research. Looking to the future, some NSF supported programs have begun to focus on new types of synthesis/symbiosis between electronic systems and biological systems, even down to the genetic level ([0210332](#)), development, functionalization, and assembly of nanoscale biological sensors, ([0210238](#)) ink-jet production of nanostructured matrices and particles for controlled gene delivery).

[0000485](#)

Funded under: PEOPLE
Award Title: Zeolite-Supported Ruthenium Catalysts for Carbon Monoxide Hydrogenation Reaction
PI Name: Jale Akyurtlu
Institution Name: Hampton University

[0210656](#)

Funded under: TOOLS
Award Title: NER: Bioelectronic Interfacing of Living Cells via Self-Assembled Microwires
PI Name: Orlin Velev
Institution Name: North Carolina State University

[0102950](#)

Funded under: IDEAS
Award Title: NIRT: Dynamics of Structure and Charge at the Molecular Scale
PI Name: Michael Fuhrer
Institution Name: University of Maryland College Park

[0122419](#)

Funded under: IDEAS
Award Title: ITR/SY: Center for Bits and Atoms
PI Name: Neil Gershenfeld
Institution Name: Massachusetts Institute of Technology

[0210552](#)

Funded under: IDEAS
Award Title: NIRT: Philosophical and Social Dimensions of Nanoscale Research: Developing a Rational Approach to a Newly Emerging Science and Technology
PI Name: Davis Baird
Institution Name: University South Carolina Research Foundation

[0210332](#)

Funded under: IDEAS
Award Title: NIRT: Development, Functionalization, and Assembly of Nanoscale Biological Sensors
PI Name: Seunghun Hong
Institution Name: Florida State University

[0210238](#)

Funded under: IDEAS
Award Title: NIRT: Ink Jetting of Nanostructured Matrices for Controlled Gene Delivery
PI Name: Prashant Kumta
Institution Name: Carnegie-Mellon University

- ***Mathematical Sciences***

This priority area has an impressive array of research from commutative algebra, geometry and statistics to wildfire hazard recognition. The research is exciting and is not only representative of the quality of NSF's investments (illustrated by the [Sloan Fellows](#) and [Japan Prize](#) winners ([0203203](#), [0104087](#))) but also includes several concerted efforts to increase participation of underrepresented groups. Examples include:

- ✓ The Sloan Fellows in mathematics outcome ([0204142](#), [0233549](#), [0202989](#)), which shows that NSF supported 16 of the 20 2003 Sloan Fellows in the field of mathematics. This is an impressive percentage and a clear indication that NSF is supporting important research.
- ✓ The "Fundamental Problems in the Dynamics of Thin Viscous films and Fluid Interfaces" project ([0074049](#), [0073841](#)) has an impressive publications list of sixty recent papers. This multidisciplinary research group combines experimental, analytical and computational capability to study fundamental problems in the dynamics of thin viscous films. The group's work is leading to improved techniques for industrial problems ranging from design of paints and microchip fabrication to medical applications, while providing a

vibrant interdisciplinary training experience for students and postdoctoral researchers.

- ✓ Another important example is aimed at increasing the participation of underrepresented groups in the mathematical sciences ([0233785](#)). This is a large scale, concerted effort that contributes to development of a diverse workforce in the mathematical sciences through participation of underrepresented groups.

[0203203](#)

Funded under: PEOPLE
Award Title: Fractal Geometry: Summer Workshops and Other Outreach
PI Name: Benoit Mandelbrot
Institution Name: Yale University

[0104087](#)

Funded under: IDEAS
Award Title: Applications of Nonlinear Dynamics
PI Name: James Yorke
Institution Name: University of Maryland College Park

[0204142](#)

Funded under: PEOPLE
Award Title: Topology and Geometry of 3-Dimensional Manifolds
PI Name: Peter Shalen
Institution Name: University of Illinois at Chicago

[0233549](#)

Funded under: PEOPLE
Award Title: Derivation and Simulation in Radiative Transfer Theory
PI Name: Guillaume Bal
Institution Name: Columbia University

[0202989](#)

Funded under: PEOPLE
Award Title: Arithmetic and Lifting of Automorphic Forms
PI Name: Wee Teck Gan
Institution Name: Princeton University

[0074049](#)

Funded under: IDEAS
Award Title: Collaborative proposal: Focused Research Group on Fundamental Problems in the Dynamics of Thin Viscous Films and Fluid Interfaces
PI Name: Andrea Bertozzi
Institution Name: Duke University

[0073841](#)

Funded under: IDEAS
Award Title: Collaborative Proposal: Focused Research Group on Fundamental Problems in the Dynamics of Thin Viscous Films and Fluid Interfaces
PI Name: Michael Shearer
Institution Name: North Carolina State University

[0233785](#)

Funded under: PEOPLE
Award Title: University of Maryland Graduate Rewards Program
PI Name: Daniel Rudolph
Institution Name: University of Maryland College Park

- ***Social, Behavioral and Economic Sciences (SBE)***

NSF'S new Human and Social Dynamics initiative is a very promising approach to furtherance of its objectives in Ideas, Tools and People. The initiative recognizes that historical disciplinary boundaries are breaking down as researchers find that they must integrate theoretical and methodological approaches across several disciplines to address research questions located at the frontiers of knowledge and that also have high societal relevance (examples: language acquisition and learning; decision making under uncertainty). The initiative builds upon and further strengthens the research infrastructure (e.g., large-scale experimental laboratories, national surveys and other forms of data) increasingly necessary for the conduct of leading-edge, collaborative, multidisciplinary research in the social, behavioral and economic sciences. Also impressive are the combination of extensive consultation with multiple research communities and the foresight of NSF personnel in setting the content and structure of this initiative. (NSF budget request FY 2004, [Section on SBE](#))

- ***Core Research and Education Activities***

The Committee found the collection of core research activities to be very impressive. Research areas include (but are not limited to) cosmology, quantum science and technology, cyberinfrastructure, computational sciences and environmental sciences. With few exceptions, the accomplishments and examples demonstrate important core research with significant societal value and important investments for future scientific discovery. One excellent example is a collaborative research program that introduces underrepresented minorities to leading-edge research conducted at both Hampton University and the University of Virginia. This example combines important, relevant research with education and diversity ([0000485](#)). Another example is a multidisciplinary research effort that addresses the important issues associated with earthquakes ([9813752](#)). In yet another example, research into insect-specific neurotoxins has the potential to lead to insecticides that are not harmful to humans ([9983243](#)). A new research effort illustrates NSF's leadership in cutting-edge, relevant research. This project is noteworthy because it is one of the first to offer the possibility of using a designed shape and structure formed by aggregates of special surface-active molecules to impose a desired structure onto more stable polymer materials. Finding conditions where these shapes are stable has been an important accomplishment necessary to enable practical production methods ([0210485](#)).

[0000485](#)

Funded under: PEOPLE
Award Title: Zeolite-Supported Ruthenium Catalysts for Carbon Monoxide Hydrogenation Reaction
PI Name: Jale Akyurtlu
Institution Name: Hampton University

[9813752](#)

Funded under: IDEAS
Award Title: Friction from Atomic to Tectonic Scales
PI Name: Jean Carlson
Institution Name: University of California-Santa Barbara

[9983243](#)

Funded under: IDEAS
Award Title: Structure-Function Studies of Novel Insecticidal Toxins
PI Name: Glenn King
Institution Name: University of Connecticut Health Center

[0210485](#)

Funded under: IDEAS
Award Title: NER: Polymer Nanowires Synthesized on a Flat Surface Via a Surfactant Template
PI Name: Brian Grady
Institution Name: University of Oklahoma Norman Campus

- ***Science of Learning Centers***

The Science of Learning Centers Program represents an important effort to expand the knowledge about learning. NSF will support large-scale, multidisciplinary, long-term Centers that will extend the frontiers of knowledge on learning and create the intellectual, organizational, and physical infrastructure needed for the long-term advancement of learning research. Areas include psychological, social and pedagogical aspects of learning, the biological basis of learning, machine learning, learning technologies, and mathematical analyses and modeling of all of these. It will also make 'catalyst' awards designed to enable partnership-building and research activities leading to the creation of new Centers. This initiative is creating synergy among traditionally isolated fields of inquiry around learning and should generate exciting new knowledge about learning in a modern, complex society. (Program Solicitation: [NSF 03-573](#))

- ***Climate Change Research Initiative (CCRI)***

The *Climate Change Research Initiative* (CCRI) is a broad, multi-agency program of considerable importance to society announced by the President in June 2001. For further information see *The Climate Change Research Initiative* (<http://www.climatescience.gov/about/ccri.htm>). Research funded by participating agencies holds promise for reducing the uncertainties related to human-induced climate change. It also has the objective of facilitating full use of scientific information in policy and decision-making on possible response strategies for adaptation and mitigation in the next 2-5 years. Examples of NSF-sponsored CCRI projects that have the potential for significant findings are illustrated by a study of African ice cores to understand tropical droughts ([9910172](#)) and the study of ice stream behavior to understand the dynamics and the stability of the West Antarctic ice sheet ([0296200](#)).

[9910172](#)

Funded under: IDEAS
Award Title: Ice Core Paleoclimate Study of East African Monsoon and ENSO Variability from the Ice Fields of Kilimanjaro
PI Name: Lonnie Thompson
Institution Name: Ohio State University Research Foundation

[0296200](#)

Funded under: IDEAS
Award Title: Antarctic Network of Unattended Broadband Integrated Seismometers (ANUBIS)
PI Name: Sridhar Anandakrishnan
Institution Name: Pennsylvania State Univ University Park

- ***Areas of Emphasis***

It is again clear that areas of emphasis have been a successful strategy for NSF, particularly where the area has proven to be one encouraging interdisciplinary research. A plethora of examples exist in NSF's portfolio and include research on anonymous markets and ethnicity, ([9709237](#)); the access-broadening effects of digitizing cuneiform tablet images ([0000629](#)) (it is interesting to speculate on the effect such availability might have had on such difficult tasks as the decoding of Linear B (similar to tablets found in excavations of Knossos); and finally the public-safety implications of electro-magnetic fields (an increasing concern of some segments of society), suggested by studies of strong static magnetic fields on cell-division in embryos ([9816986](#)).

[9709237](#)

Funded under: IDEAS
Award Title: Anonymous Markets and Coethnic Ties in International Trade
PI Name: Alessandra Casella
Institution Name: National Bureau of Economic Research Inc

[0000629](#)

Funded under: TOOLS
Award Title: Cuneiform Digital Library Initiative
PI Name: Robert Englund
Institution Name: University of California-Los Angeles

[9816986](#)

Funded under: IDEAS
Award Title: Manipulation of Cell Division with Static Magnetic Fields
PI Name: James Valles
Institution Name: Brown University

G. OUTCOME GOAL: TOOLS

TOOLS OUTCOME GOAL: FOUNDATION-LEVEL SUMMARY

- **Provide an overall assessment of progress toward attainment of this outcome goal.**

The Committee concludes that there is significant achievement in all indicators of the TOOLS strategic outcome goal.

The goal of the TOOLS portfolio is to provide broadly accessible, state-of-the-art and shared facilities and infrastructure to support research and education across the Foundation. NSF provides support for large, multi-user facilities that allow researchers access to state-of-the-art facilities. Support for these unique national and global facilities is necessary to advance and maintain the U.S. capabilities as the world leader in research. NSF investments include internet-based and distributed user facilities, advanced computer resources, research networks, major research instrumentation, digital libraries, and large databases, all of which contribute to a state-of-the-art research and education infrastructure.

In reaching its overall conclusions, the Committee evaluated the TOOLS Goal Indicators, Areas of Emphasis for Investment in Emerging Opportunities, and Areas of Emphasis for GPRA Reporting. In addition to the TOOLS retrospective accomplishments and prospective examples, the Committee reviewed budget requests, COV reports and documents selected from the NSF ACGPA website, including information on awards. The combination of the documents reviewed and the Committee's collective experience provides a basis for the Committee's overall conclusions and detailed findings.

The Committee concluded that NSF made significant achievements across the entire set of TOOLS Indicators, Emerging Opportunities, and Areas of Emphasis. NSF support of research infrastructure allowed wider and more effective dissemination of data and materials, enhanced the productivity of and enabled the capacity for discovery by researchers and educators, and increasingly expanded access to and availability of resources. NSF-supported activities continue to determine a high rate of progress in many science and engineering disciplines including astronomy and Earth science. Examples of the types of new tools that support the Committee's findings include: widely-available and networked state-of-the-art instruments, World-scale digital libraries and repositories of data from unique sources ranging from many distinct spectral bands in astronomy to real-time data from integrated networks of advanced sensors on phenomena in the Earth's interior, new educational hard- and software that enables the visually impaired to engage in leading-edge research in the sciences and Internet technology that enables capacities for discovery and enhances the productivity of researchers, educators, and students in remote locations.

The Committee observed that there seemed to be a "gap" between the types of projects supported by [Major Research Equipment and Facilities Construction](#) (MREFC) account and those supported by the [Major Research Instrumentation](#) (MRI) program. That is, instrumentation and facilities in the range of \$2 million to \$50 million did not seem to have an obvious "home." This range of instruments and facilities is of great importance to many disciplines and to a wide range of institutional types. Therefore, the Committee recommends that NSF give strong consideration to developing a program to support the acquisition of mid-sized instrumentation in the range of \$2-\$50 million.

The Committee also observed that NSF has played a large and vital leadership role in developing and providing access to research facilities. The Committee recommends that NSF consider ways in which these facilities investments can be sustained over the long-term to maximize their value to intellectual endeavor. In this regard, NSF should continue to reassess the balance between ongoing commitments and new opportunities in the Tools portfolio.

- **Provide an overall assessment of whether there appear to be particularly promising efforts likely to enable achievement of NSF's desired outcomes in the future**

Throughout its history, the Foundation has provided the U.S. academic community with the resources to develop, access and maintain facilities and infrastructure for research unequalled anywhere else in the world. This infrastructure has come from direct NSF investments, as well as NSF's role as a leader and catalyst for national and international partnerships. A retrospective assessment of NSF investments in infrastructure on the decadal scale, in areas such as astronomy, deep sea processes, climate change and computer networking, shows the value of investment in tools as a fundamental underpinning of almost all areas of NSF research. An assessment of more recent investments in infrastructure, as carried out during this ACGPA review, confirms that NSF investment in new and ongoing facilities continues to serve a vital research community. As the research enterprise becomes more and more reliant on sophisticated instrumentation, complex observational systems, voluminous data and innovative analysis techniques, there is increasing need for careful planning to develop and maintain a vibrant research infrastructure for the future.

At the Foundation level, planning and implementation related to major new infrastructure have focused on the Major Research Equipment and Facilities Construction (MREFC) program to establish large facilities and the Major Research Instrumentation (MRI) program for smaller instruments. In the near term, the FY04 NSF Budget request (http://www.nsf.gov/bfa/bud/fy2004/pdf/fy2004_16.pdf) sets priorities for MREFC investments for the next three years. The MREFC program is the critical program for the development of major new scientific and research infrastructure with a total cost in the range of \$100 million or more. For smaller infrastructure needs, the MRI program is an outstanding program of enormous importance to the nation's institutions of higher education. Since 1997 the MRI program has funded over 1,200 instrumentation projects at hundreds of colleges and universities, each in the range of \$100,000 to \$2 million. The Committee agrees with the recent recommendations by the National Science Board that there is a need for a program to fund mid-sized infrastructure with a total cost between the ranges supported by MREFC and MRI. The establishment of such a program is necessary to enable achievement of NSF's desired outcomes for the TOOLS goal in the future.

A recent Cyberinfrastructure report [<http://www.cise.nsf.gov/evnt/reports/toc.htm>] provides an outstanding opportunity for the more coordinated investment in instruments

and their supporting digital infrastructure such as storage, computation and high-speed networking. The very recent report from the National Science Board (NSB) on “[Science and Engineering Infrastructure for the 21st Century](#)” provides a roadmap for future investments in the NSF “Tools” portfolio. These forward-looking plans present a strategic basis for assessing the needs of the research community and build on the tradition of strong NSF investments in infrastructure. The NSB report on infrastructure calls for increased funding of infrastructure at all levels; expanding the concept of infrastructure to include distribution systems of hardware, software, information databases, automated aids for data analysis and interpretation and linking these to training and education facilities. In addition the plan calls for a strengthened planning and budgeting process and enhanced interagency planning and partnerships. The report also highlights the need for investment in the technologies that will enable future state-of-the-art facilities. With this framework now set by the NSB, the research community must engage with NSF to more clearly define the specific needs for future infrastructure support.

- **For each Area of Investment in Emerging Opportunity⁵ associated with the TOOLS goal, comment on whether there appear to be particularly promising efforts likely to enable achievement of NSF’s desired outcomes in the future.**

NSF continues to make significant investments in emerging opportunities for broadly accessible, state-of-the-art and shared research and education tools. Planned investments include projects supported within the Major Research Equipment and Facilities Construction ([MREFC](#)) Account (e.g., [NEON](#), [EarthScope](#), and [ALMA](#)), the [Science Resources Statistics \(SRS\) Survey Redesign](#), and the [National STEM Education Digital Library](#). The highest priority for investment within the MREFC Account is ongoing projects. Second priority is new projects that have received National Science Board approval for inclusion in future budget requests but which have not yet received funding. The list of active and proposed projects includes research and education tools designed to respond to the needs of the NSF supported research communities. Initial concept and development of new opportunities for investment is supported through the Research and Related Activities Account. These investments are likely to result in a continuous stream of high quality proposals for MREFC funding, provided that the backlog of NSB approved projects is manageable, i.e., successful proposals are funded within a reasonable period of time.

There are many promising efforts toward the goal of providing "broadly accessible, state-of-the-art and shared research and education tools" in the future. NSF budgets recognize that a modern and effective research infrastructure is critical to maintaining U.S. leadership in science and engineering and that the future success of research communities depends upon access to new generations of powerful research

⁵ Major Research Equipment and Facilities Construction (new investments): NEON, EarthScope, ALMA II); Science Resources Statistics (SRS) Survey Redesign; National STEM Education Digital Library.

tools. The MREFC Account provides funding for the largest and most complex tools supported by NSF. These tools include plans for enabling broad access for research and education communities. During the evaluation period there was a clear emphasis on funding existing projects with new construction starts deferred until the later years, e.g., Scientific Ocean Drilling in FY 2005; Rare Symmetry Violating Processes in FY 2006; and Ocean Observatories in FY 2006. Future success will be highly dependent on both the successful completion of current projects and the initiation of new projects so that MREFC program produces new operating equipment and facilities on a continuous basis. A discontinuity in support for the construction of new tools would adversely effect future performance.

These conclusions are based on the evaluation of the three Areas of Investment in Emerging Opportunity. The first area is the MREFC program. Two prospective examples of investment that should lead to future achievement in providing broadly accessible, shared research and education tools are *EarthScope* (www.EarthScope.org) and the *Extensible Terascale Facility* ([0122272](#), [0122296](#), [0085206](#)). EarthScope is a scientific infrastructure initiative for new observational facilities that will address fundamental questions about the evolution of continents and the processes responsible for earthquakes and volcanic eruptions. The integrated observing systems that will comprise the EarthScope Observatory capitalize on recent developments in sensor technology and communications to provide Earth scientists with synoptic and high-resolution data derived from a variety of geophysical sensors. All data from the EarthScope Observatory will be openly available in real-time to maximize participation from the scientific community and to provide on-going educational outreach to students and the public. The Extensible Terascale Facility (ETF) is a scalable, distributed, heterogeneous grid computing-communication-information system. Scheduled for commissioning in the fall of 2004, the ETF will provide for the seamless integration of high-end computing platforms, large archival science and engineering data resources, cutting-edge visualization facilities, and research-enabling instruments and sensors. ETF will allow scientific collaborators to share computational and archival data resources on an unprecedented scale, and allow geographically distributed teams of researchers to work together on large-scale scientific problems.

The second Area of Investment in Emerging Opportunity is the Science Resources Statistics (SRS) Survey Redesign. Two prospective examples of investment that should lead to future achievement are the *Study of Research and Development Statistics at the National Science Foundation* ([0244598](#)) and the *Survey of Science and Engineering Research Facilities* ([0136523](#)). Productivity will be enhanced in the research community as a result of the improvements in R&D statistics that emanate from the recommendations in the Study of Research and Development Statistics at the National Science Foundation. The Survey of Science and Engineering Research Facilities will provide more extensive information on the status of research facilities and, for the first time, data on cyberinfrastructure in academia.

The third Area of Investment in Emerging Opportunity is the National STEM Education digital library. One example of a supported project that should enable future

achievement is *eSkeletons: An Interactive Digital Library of Human and Primate Anatomy* ([0226040](#)). The project provides students with a tool to gain a more complete understanding of the range of primate diversity through examination of human and primate anatomy.

[0208457](#)

Funded under: TOOLS
Award Title: Earthscope: A New View of Earth and Earth Science
PI Name: Michelle Hall-Wallace
Institution Name: University of Arizona

[0122272](#)

Funded under: TOOLS
Award Title: The TeraGrid: Cyberinfrastructure for 21st Century Science and Engineering
PI Name: Francine Berman
Institution Name: University of California-San Diego

[0122296](#)

Funded under: TOOLS
Award Title: The TeraGrid: Cyberinfrastructure for 21st Century Science and Engineering
PI Name: Daniel Reed
Institution Name: University of Illinois at Urbana-Champaign

[0085206](#)

Funded under: TOOLS
Award Title: Terascale Computing System
PI Name: Michael Levine
Institution Name: MPC Corporation

[0244598](#)

Funded under: TOOLS
Award Title: Study of Research and Development Statistics at the National Science Foundation
PI Name: Andrew White
Institution Name: National Academy of Sciences

[0136523](#)

Funded under: TOOLS
Award Title: Redesign of the Science and Engineering Research Facilities Survey
PI Name: Brad Chaney
Institution Name: Westat Inc

[0226040](#)

Funded under: TOOLS
Award Title: www.eSkeletons.org: An Interactive Digital Library of Human and Primate Anatomy
PI Name: John Kappelman
Institution Name: University of Texas at Austin

- **For each Areas of Emphasis for GPRA Reporting⁶ associated with the TOOLS goal, comment on whether NSF has demonstrated significant achievement within the portfolio of activities associated with these areas**

- ***Major Research Equipment and Facilities Construction (current and former): e.g., ALMA I, LIGO, Gemini, LHC, NEES, SPSM, Terascale Computing;***

NSF has demonstrated significant achievement in the MREFC program. It continues to fund major scientific facilities that provide unique environments for discovery in a range of disciplines. In fact, it is the principal supporter of large-scale non-military scientific infrastructure in the nation. It funds a remarkable spectrum of activities that range from the Polar research facilities (which in turn support a diverse research portfolio, including projects in physics and environmental sciences), through an array of widely-differing scientific facilities focused on deepening and improving our fundamental understanding of the universe, to the country's premiere open high performance computing centers.

- ✓ The *Laser Interferometric Gravitational wave Observatory (LIGO)* ([0107417](#)), commissioned last year, has been built to detect cosmic gravitational waves predicted by Einstein's theory of Relativity. If successful, this facility and those in Europe and Japan with which it works closely, will allow observations of celestial events from an entirely different perspective. LIGO may yield a picture of the heavens that is totally different from that produced by astronomy, cosmic rays, or neutrinos, a picture which may contain coalescing black holes or neutron stars, exploding stars, and other exciting but unanticipated cosmic phenomena.
- ✓ The *George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES)* ([0086624](#)) will be a national shared use resource for earthquake engineering and education during 2005 – 2014.
- ✓ During 2003, the *National Center for Atmospheric Research (NCAR)* carried out a major upgrade of its IBM supercomputer (known as "[Blue Sky](#)") ([9732665](#)). NCAR now has the 10th most powerful computer in the world. This system has a peak speed up to seven trillion calculations (tflops) per second and includes 21 terabytes of new disk storage. NSF purchased the machine for use at NCAR to advance a wide range of research topics in the agency's 10-year plan for the geosciences. Blue Sky is expected to accelerate research in global and regional climate change, droughts, short- and long-range weather prediction and warnings, wild land fires, turbulence, atmospheric chemistry, space weather, and other critical areas.

⁶ Major Research Equipment and Facilities Construction (current and former): e.g., ALMA I, LIGO, Gemini, LHC, NEES, SPSM, Terascale Computing; Major Research Instrumentation (MRI) Program; Science and Engineering policy analyses, information, reports and databases; Scientific databases and tools for using them, including the National STEM Education digital library.

[0107417](#)

Funded under: TOOLS
Award Title: Support for Operations and Management of LIGO
PI Name: Barry Barish
Institution Name: California Institute of Technology

[0086624](#)

Funded under: TOOLS
Award Title: Development of a biaxial multiple shake table research facility
PI Name: Ian Buckle
Institution Name: University of Nevada Reno

[9732665](#)

Funded under: TOOLS
Award Title: Operation of the National Center for Atmospheric Research and Support of Other Scientific Activities
PI Name: Richard Anthes
Institution Name: University Corporation For Atmospheric Res

- ***Major Research Instrumentation (MRI) Program.***

NSF has demonstrated significant achievement in the [Major Research Instrumentation Program](#) (MRI). This is an outstanding program of enormous importance to the nation's institutions of higher education. Since 1997 the MRI program has funded over 1,200 instrumentation projects at hundreds of colleges and universities.

This program is designed to improve the condition of scientific and engineering equipment for research and research training in the nation's academic institutions. It seeks to improve the quality and expand the scope of research and research training in science and engineering, and to foster the integration of research and education by providing instrumentation for research-intensive learning environments.

The [MRI Program](#) assists in the acquisition or development of major research instrumentation by U.S. institutions that is, in general, too costly for support through other NSF programs. The maintenance and technical support associated with these instruments are also supported. Proposals may be for a single instrument, a large system of instruments, or multiple instruments that share a common research focus. Proposals for computer systems, clusters of advanced workstations, networks, and other information infrastructure components necessary for research are encouraged.

Awards for instrumentation range from \$100,000 to \$2 million. Lesser amounts are considered in proposals from non-Ph.D. granting institutions, from mathematical sciences, or from the social, behavioral and economic science communities

- ***Science and Engineering policy analyses, information, reports and databases; scientific databases and tools for using them, including the National STEM Education digital library.***

NSF has demonstrated significant achievement in the funding of the development of scientific databases. In addition to supporting more traditional scientific databases, the NSF has supported the development of some highly innovative databases (thought of in a broad sense) that are using modern sophisticated IT tools to provide new and deeper insights into widely diverse areas of research.

The “[Mining the Bibliome](#)” ([0205448](#)) project seeks to use new techniques from computational linguistics to extract information structured in terms of well-defined relations from the many millions of biomedical publications available in electronic form that contain a vast quantity of scientific information. The goal of this research is qualitatively better methods for automatically extracting information from the biomedical literature.

The “[Forma Urbis Romae](#)” ([0113427](#), [0219856](#)) project employs state of the art digital techniques to reconstruct a key archaeological resource concerning ancient Rome - 1,186 pieces of a large map from the 2nd Century - for studying the city at that time.

[0205448](#)

Funded under: IDEAS
Award Title: ITR: Mining the Bibliome -- Information Extraction from the Biomedical Literature
PI Name: Aravind Joshi
Institution Name: University of Pennsylvania

[0113427](#)

Funded under: TOOLS
Award Title: ITR: Solving the Puzzle of the Forma Urbis Romae
PI Name: Marc Levoy
Institution Name: Stanford University

[0219856](#)

Funded under: TOOLS
Award Title: ITR: High Performance Imaging Using an Array of Low-Cost Cameras
PI Name: Marc Levoy
Institution Name: Stanford University

H. COMMENTS ON THE PROCESS AND THE COMMITTEE'S WORK

The Committee again wishes to thank the many staff at NSF who worked very hard to make this process for assessing NSF's performance a success. We recognize that there were no models or other templates to follow for this process and we very much appreciate that NSF made a major effort over the past year to respond positively to the Committee's previous suggestions. In that spirit, we have some new observations, suggestions and recommendations.

1. The Committee is pleased that NSF has made significant improvements in the database for accomplishments and examples, particularly in improved consistency of presentation and reduced jargon, but more could be done. We urge NSF to continue to emphasize jargon-free writing and continue to focus on relating the accomplishments and examples to the indicators.
2. The background information on accomplishments and examples provided to the Committee continues to be unevenly distributed across the Directorates. NSF should continue to strive to reduce this unevenness by tasking the Directorates to review the distribution of accomplishments and examples in areas relevant to them and NSF should ensure that there are at least a few accomplishments and examples from the major programs that cross directorate boundaries (e.g., priority areas of emphasis and investment). This would result in even a more robust database. However, the Committee appreciates the fact that the process for generating accomplishments and examples continues to be "bottoms up," driven by the expert judgment of the program staff.
3. The Committee discussed again the issue of sampling. As noted above, NSF should work to resolve the remaining unevenness in the database. The Committee appreciates the effort that NSF made to explore this issue in response to our comments last year and we note that NSF sought the views of experts in this area before deciding to continue the use of judgmental sampling. The Committee believes that a purposeful sampling technique, i.e., one that relies on the judgment of internal experts (NSF program staff) combined with review by an external group of experts, is appropriate, reasonable and useful for GPRA reporting purposes. Such a technique will provide adequate data on which to base conclusions about performance relative to NSF's outcome goals
4. The Committee notes that the portfolio of prospective examples seems a bit thinner than last year. We attribute that to the combination of the earlier date for the committee's meeting (three months) and the fact that the FY 2003 appropriations were not received until the second quarter of FY 2003. Because of this fact, NSF has not made as many awards as it normally would have if appropriations had been received in a more timely way. The Committee

recognizes that this situation is not under NSF's control and sincerely hopes that this will not be the case in future years.

5. The Committee appreciates that NSF has made additional resources available this year (e.g., more Committee of Visitors reports, the entire project reports database with a robust search engine.) These resources have helped to enrich the Committee's deliberations and this report.
6. The Committee believes that the process this year was considerably smoother than last year but also believes that it could be made even more efficient and effective by enabling members to use personal laptop computers and web-based tools and folders both while at NSF and from the other sites. In addition, the Committee suggests that NSF investigate the use of one or more interactive "e-workshops" in advance of the face-to-face meeting of the full Committee. Several members noted that this would have enabled much of the indicator analysis and writing to have been done ahead of time without the need for travel, thus shortening the time needed for the full Committee to interact personally. Additional steps that might prove helpful to the efficiency of the process would be a "pre-meeting" (perhaps via teleconference) with the subcommittee chairs and a template for the report that is somewhat more structured.
7. The Committee believes that in the future, it would be wise to eliminate specific consideration of the Areas of Emphasis (both for GPRA reporting and for investment in emerging opportunity). The objective and the focus of GPRA reporting is and should be on whether NSF has demonstrated significant achievement for its performance goals. The Areas of Emphasis, no matter how exemplary, are means to that end, not an end in themselves. The Committee sees no compelling rationale for or added value in calling these areas out specifically for analysis relative to all other NSF programs. Rather, accomplishments and examples from these areas should simply be included in the NSF-wide database.

While the Committee appreciates the fact that the Government Performance and Results Act mandates an annual review, we also recognize and reiterate that assessment of NSF's entire research and education portfolio each year may not be the most effective way of assuring accountability. In any case, it will be important to retain a holistic and integrated view of the strategic goals and annual performance goals, reflecting their strong synergy.

8. The Committee continues to believe that an independent assessment of NSF's performance is a valuable exercise to ensure that experts other than those within NSF review and validate outcomes linked to the agency's strategic goals. Nevertheless, the current process is still too cumbersome and often frustrating for many Committee members. These frustrations stem, in part, from the very, very large volume of material supporting this performance assessment that the Committee must review in a very short time, and the lingering belief that the time

of the Committee is not being used as productively as it could be to assist NSF in achieving its important mission.

For next year, we urge NSF to consider an approach that involves a significant component of “self study”. A greater number of NSF staff should be more involved with the selection and preparation of accomplishments and examples. These data and others would form the basis for a self-study that would be based on NSF’s strategic goals and objectives and a set of performance indicators in key areas. The study would be data-driven and would provide key information at multiple levels of detail. The completed study would then be provided to the AC/GPA along with open access to all supporting information.

The Committee could then continue to serve in the role of the independent assessment team, using the data resources provided by NSF. It could provide strategic observations and render its judgment on both NSF’s performance and the validity of the data that underpinned the self-study. It could even expand on the self-study if it thought that was warranted.

The Committee believes that this approach is a reasonable one to consider for NSF’s performance assessment process in the future. Such a process would provide, we believe, an appropriate level of both transparency and independence and would enhance the quality of the Committee’s work. Perhaps more importantly, such a process could serve as a valuable internal mechanism for NSF to evaluate its own performance against its strategic goals and performance plans.

APPENDIX:

PEOPLE OUTCOME GOAL: DETAILED ASSESSMENT OF PERFORMANCE

NSF OUTCOME GOAL FOR PEOPLE: DEVELOPING A “DIVERSE, INTERNATIONALLY COMPETITIVE AND GLOBALLY ENGAGED WORKFORCE OF SCIENTISTS, ENGINEERS, AND WELL-PREPARED CITIZENS.”

GOAL III-1a: NSF’s performance for the People Strategic Outcome is successful when, in the aggregate, results reported in the period demonstrate significant achievement in the majority of the following indicators:

FY 2003 Annual Performance Indicators

P1: Development of well-prepared researchers, educators or students whose participation in NSF activities provides experiences that enable them to explore the frontiers or challenges of the future.

Retrospective analysis:

- *Has NSF demonstrated significant achievement for this indicator as a result of the outcomes of past awards? YES*

Currently NSF is funding a host of programs that provide a path to achievements for a diverse internationally competitive and globally engaged workforce of scientists, engineers and well-prepared citizens. Programs like Research Experiences for Undergraduates, and Research Experiences for Teachers are noteworthy. The Committee notes that although there were no accomplishments for the Minority Institutions Infrastructure Program, the Committee believes that this program also contributes to the achievement of this indicator.

The Division of Experimental and Integrated Activities in the CISE directorate (EIA) is a unique NSF program. It combines infrastructure, instrumentation and workforce programs with a portfolio of broad-based research programs (CISE Challenges, Experimental Systems, Experimental Software Systems, etc.). With the start of the Information Technology Research (ITR) Program, EIA began targeting its research funding towards enabling interdisciplinary research in new areas where IT research interfaces with other research areas such as biology, education, social science, and government, and where new IT research could be informed by application-specific needs and constraints.

EIA manages a large portfolio of programs (over 50); some as base programs for the Division, others collaboratively with other directorates where EIA may represent the

Division's interests or those of CISE as a whole, and some through cross-NSF programs in which EIA participates on behalf of CISE or, in a few cases, only on behalf of the Division. EIA has organized its programs into four areas: Multi-Disciplinary Research; Instrumentation and Infrastructure; Education and Workforce; and Symposia, Travel, Studies and International Activities. Each of these categories includes base, collaborative and cross-NSF programs. These programs encompass all of the areas mentioned in this Indicator.

The Multi-Disciplinary Research programs include base programs covering research at the interface of biology and information technology, research in IT-enabled education and learning, research in digital government and governance, and research in application systems and software. This area also encompasses EIA activities related to the NSF priority areas: Information Technology Research, Nanoscale Science and Engineering, Biocomplexity in the Environment, and Science of Learning Centers. In the first two, EIA is one of several CISE divisions participating, while in the latter two EIA is the primary CISE participant. EIA also manages the Science and Technology Centers grants assigned to CISE.

The efforts in these programs are supported by some retrospective nuggets that show significant growth in these areas.

Increasing U.S. citizens and women in Mathematical Sciences Graduate Programs

[9977134](#)

Funded under: PEOPLE
Award Title: VIGRE: The University of Chicago's Vertical Integration Program
PI Name: J. Peter May
Institution Name: University of Chicago

[9983726](#)

Funded under: PEOPLE
Award Title: UCLA Mathematics Department 1999 VIGRE Proposal
PI Name: Robert Greene
Institution Name: University of California-Los Angeles

The VIGRE program whose main purpose is to increase the number of U.S. citizens and permanent residents who have completed a Ph.D. in the mathematical sciences is succeeding in that objective. Of the sites reviewed in their third year this year, all but one increased the number of their graduate students from before VIGRE to their third year of operation. The numerical increases are between 3 and 59 with percentage increases ranging as high as 71%. The number of U.S. citizens and permanent residents went up at all but one with increases ranging between 1 and 26 (including a percentage increase of 55%).

NCAR Undergraduate Leadership Workshop

[9732665](#)

Funded under: PEOPLE
Award Title: Operation of the National Center for Atmospheric Research and Support of Other Scientific Activities
PI Name: Richard Anthes
Institution Name: University Corporation For Atmospheric Res

In June 2002, NCAR hosted the first annual NCAR Undergraduate Leadership Workshop with the purpose of informing students about the potential for exciting research and career opportunities in the atmospheric and related sciences. The five-day workshop established informal dialogue between students and research scientists as they explored laboratories, instrumentation, and computing facilities that support studies on weather, climate change, solar dynamics, the Sun-Earth system, and the impacts of severe weather and climate change on societies around the world.

Developing a children's digital library environment containing rich multimedia resources.

[0205082](#)

Funded under: PEOPLE
Award Title: ITR: Developing a Children's International Digital Library
PI Name: Allison Druin
Institution Name: University of Maryland College Park

[9909086](#)

Funded under: IDEAS
Award Title: DLI-Phase 2: Digital Libraries for Children
PI Name: Allison Druin
Institution Name: University of Maryland College Park

(<http://www.cs.umd.edu/hcil/kiddesign/searchkids.shtml>)

Over the three years of the project, this team developed visual interfaces that support young children (ages 7-9 years) in querying, browsing, and organizing multimedia information. In doing so, the team worked with children and teachers as "design partners" to develop new digital library technologies that support the learning challenges of young children. This demonstration project focused on multimedia resources of animal information donated by the Discovery Channel and the Patuxent Wildlife Research Center. The outcomes of the project to date include:

The project developed a digital library prototype (SearchKids) where children can search for animals using a scalable visual querying interface. Multiple children can use this tool at the same time thanks to a special interface that enables multiple mice to be used simultaneously on one computer. This tool is linked to a scalable presentation tool (KidPad), which enables children to use their animal resources to tell stories.

The evaluation of the software with 120 2nd and 3rd grade children was done in early elementary school classrooms to understand children's search strategies and

approaches to collaboration. These studies have shown that young children not normally capable of complex Boolean searches can do so more efficiently and accurately given a visual interface. In addition, collaboratively navigating information necessitates various interface technologies that encourage cooperation and peer learning.

Generalization of the interface has begun on two fronts. The team has begun generalizing the technology infrastructure to work with other databases. It has begun generalization efforts by working with the University of Michigan's *Bio Diversity* animal database. In addition, the team has initiated a new research project with the Library of Congress and the Internet Archive to develop the [largest international children's book digital library](#) in the world. The project has just been notified that it will receive another \$3 million from NSF's ITR initiative over the next five years to complete this research.

Advanced Training Institutes in Social Psychology

[0129453](#)

Funded under: PEOPLE
Award Title: Advanced Training Institute In Social Psychology: Using The Internet To Conduct Experiments
PI Name: Michael Birnbaum
Institution Name: California State University-Fullerton Foundation

[0129717](#)

Funded under: PEOPLE
Award Title: Advanced Training Institute in Social Psychology: Immersive Virtual Environment Technology
PI Name: James Blascovich
Institution Name: University of California-Santa Barbara

[0220977](#)

Funded under: PEOPLE
Award Title: Advanced Training Institute in Social Psychology: The Social Relations Model
PI Name: David Kenny
Institution Name: University of Connecticut

[Advanced Training Institutes in Social Psychology](#) provide quality training in new methodologies, statistical procedures, and other tools to support and enhance social psychological research. NSF funding helps to establish training institutes where researchers can spend time acquiring basic skills and knowledge. One institute provides training in the use and development of immersive virtual environment technology (IVET). Another institute focuses on the use of internet technology to conduct social and behavioral science research. A third institute offers instruction in newly developed statistical methods for understanding social relations.

It is difficult both for those who are early in their careers and for senior investigators to obtain quality training in new areas. Advanced Training Institutes in Social Psychology provide one way in which such training can be obtained. These training institutes focus on the people of social psychological science, and they emphasize the integration of methods and technology from other disciplines. The training received by researchers can then be put to use in their own programs of scientific research and they can teach these new methods to their own students.

Prospective analysis:

- *Comment on the potential future impact of new activities and awards.*

There are several initiatives that provide support for the development of well-prepared researchers, educators or students whose participation in NSF activities will provide experiences that enable them to explore the frontiers or challenges of the future. For example, some core areas being addressed include highly innovative activities in biophotonics, quantitative systems biotechnology, fuel cells, bio-based design, processing and manufacturing, sensors, nano-manufacturing, organic electronics and photonics and novel approaches to self-assembly of nanostructures and devices.

The [Electrical and Communications Systems](#) (ECS) Division will be making 20-25 Small Grants for Exploratory Research awards this year. As part of this goal, ECS will focus on the challenges facing the semiconductor industry in the next 5-10 years as identified in the 2002 ITRS ([International Technology Roadmap for Semiconductors](#)). This funding will focus on innovative ways to address semiconductor manufacturing at feature sizes of 50 nm and less and the difficulties associated with interconnecting architectures and interconnecting materials at these sizes.

Research in the geosciences has been and will continue to be of critical importance to the nation. GEO investments contribute to our understanding of climate change, and are a critical component of the [U.S. Global Change Research Program](#) and the [Climate Change Research Initiative](#).

The broad portfolio of the [Office of Polar Programs](#) includes topics of interest to policymakers world-wide, ranging from ozone hole behavior to the stability of ice sheets and global sea level, as well as to emerging disciplinary research frontiers in microbiology and astrophysics.

Current NSF is encouraging the social and behavioral sciences to plan aggressively to seize future opportunities to better serve the scientific community and the nation as a whole. NSF's [Human and Social Dynamics](#) (HSD) priority area, which will begin in FY 2003 and expand in subsequent fiscal years, is explicitly designed to address many of the shortcomings, gaps, and areas of need this initiative is designed to identify. This is supported by a 142.5% increase in funding from FY 2003 to FY 2004. There is also a request for \$8.5 million for FY 2004 for a new initiative, Workforce for the 21st Century,

In FY 2003 the Biological Sciences Directorate initiated a new activity, [Frontiers in Integrative Biological Research](#), whose goal is to encourage researchers to address previously intractable biological questions by providing the resources and time required for multi-disciplinary teams to tackle them. Any biological question can be addressed and risk taking is explicitly encouraged and used as a review criteria.

The [Extensible Terascale Facility](#) will integrate NSF's Terascale Computing Facility at the Pittsburgh Supercomputing Center with the Distributed Terascale Facility (Illinois, San Diego, CalTech and Argonne) into a single facility connected by 30 gigabit per second connections. The facility will be extensible from two hubs (Chicago and Illinois) that will permit additions of new resources beginning in FY 2003 and later. This will be the underpinning of the high-performance cyberinfrastructure (see also discussion of cyberinfrastructure planning in section D).

NSF investment in the [Interagency Education Research Initiative](#) is characterized by support of research efforts that are risky and multidisciplinary; most of the funds under this program support research in the scaling of educational interventions that have garnered empirical credibility in prior studies. They are then examined for educational effectiveness in much broader settings under more highly variable contexts than is feasible in smaller settings. An innovative element of the portfolio is the integration of scaled implementation of demonstrably effective interventions with research into the scaling process itself. The prospective portfolio now includes a significant number of studies that promise to yield important conclusions and insights both on the interventions in question and on the broader question of the mechanisms for bringing an effective education intervention into broader implementation. The particular interventions include various mathematics curricula; science curricula; the implementation of high-stakes assessment and its impact on student learning; and integrated science and reading programs.

Specific examples that support this assessment are:

A New Program: Human Language and Communication

[0200983](#)

Funded under: PEOPLE
Award Title: Synthesis and Acquisition of Communicative Gestures
PI Name: Norman Badler
Institution Name: University of Pennsylvania

[0208028](#)

Funded under: IDEAS
Award Title: Reducing the Corpus Annotation Bottleneck for Natural Language Learning
PI Name: Claire Cardie
Institution Name: Cornell University - Endowed

[0208985](#)

Funded under: TOOLS
Award Title: Collaborative: Improving Subjectivity Analysis to Achieve High-Precision Information Extraction
PI Name: Ellen Riloff
Institution Name: University of Utah

A new program in Human Language and Communication (HLC) has been created to advance the state of the art in computer processing of text, speech, and multi-modal communication. The HLC program focuses on research aimed at testing new theories and developing new computational models for all aspects of human language and

communication. Such research will deepen our understanding of the relationship between text, speech, and other communicative forms, as well as their underlying meaning, intent, and realization. Support for HLC research could lead to important applications in speech/language technology for managing the vast streams of text, speech, and video interactions that are available today via the Internet and mass media, as well as a myriad of other practical applications such as more effective data mining tools for selecting information from these streams for education, business, and government, robust spoken control of mobile and embedded computers, high quality dialogue systems to enhance computer usability, and effective machine translation systems for expanded information access. As an intellectual discipline in its own right, machine processing of language raises fascinating questions about the relationship between structure and meaning and presents great technical challenges regarding how to duplicate with machines the full variety of human communication.

Emotion-Specific Influences on Judgment and Choice

[0239637](#)

Funded under: IDEAS
Award Title: CAREER: Toward a Model of Emotion-Specific Influences on Judgment and Choice
PI Name: Jennifer Lerner
Institution Name: Carnegie-Mellon University

Once an exclusively cognitive enterprise, research on judgment and decision-making increasingly addresses the powerful influence of emotion. Recent research has shown that even incidental emotion - emotion that is normatively unrelated to the judgment/decision at hand - can have a significant impact on judgment and choice. The majority of studies in this tradition have been motivated by a valence-based approach, contrasting the effects of positive versus negative emotions on judgment and choice. But there is growing evidence that specific emotions of the same valence can trigger opposing perceptions and judgments. For example, in the wake of the terrorist attacks of 9-11, experimentally induced fear produced opposite effects from anger on both risk estimates and policy preferences among U.S. citizens in a nationwide field experiment (Lerner, Gonzalez, Small, & Fischhoff, in press). From a theoretical perspective, these findings demonstrate that dimensions of emotions other than valence are also important components to include in decision models. From an applied perspective, they demonstrate how and why citizens primed for anger will endorse rather different policies than will citizens primed for fear.

The purpose of the proposed research is to develop and test a parsimonious yet powerful theory that comprehensively predicts relations among specific emotions and judgment/choice outcomes. The proposed research will expand Lerner and Keltner's (2000; 2001) appraisal-tendency framework (ATF). The ATF predicts that each emotion activates an implicit cognitive predisposition - an "appraisal tendency" - to appraise future events in line with the central appraisal dimensions that triggered the emotion. Such appraisals, although tailored to help the individual respond to the event that evoked the emotion, persist beyond the eliciting situation - becoming an implicit perceptual lens for interpreting subsequent situations. The appraisal-tendency approach provides a

flexible yet specific framework for developing a host of testable hypotheses concerning emotion, judgment, and decision-making.

Enabling Graduate Education through Undergraduate Partnership Initiatives

[0213223](#)

Funded under: PEOPLE
Award Title: Chemical Dynamics in Nonstationary Environments & Applications to Polymerization and Protein Folding
PI Name: Rigoberto Hernandez
Institution Name: Georgia Tech Research Corporation - GA Institute of Technology

[9703372](#)

Funded under: PEOPLE
Award Title: CAREER:Reaction Dynamics of Polymerization and a Computer- Enhanced Dialectic in the Physical Chemistry Curriculum
PI Name: Rigoberto Hernandez
Institution Name: Georgia Tech Research Corporation - GA Institute of Technology

In recognition of combining exceptional research with outreach activities, Professor Rigoberto Hernandez has recently been awarded the Goizueta Foundation Junior Chair at the Georgia Institute of Technology. (See: <http://www.finaid.gatech.edu/scholarships/goizueta/> and <http://www.whistle.gatech.edu/archives/02/sept/23/goizueta.html>.)

In this position, Hernandez participates in a variety of initiatives aimed at the recruitment, retention, and promotion of Latino students in science. These include participating in the selection of undergraduate scholarships and graduate supplements as well as mentoring of the awardees. Noting that many first-generation college students often focus on professional degrees, Professor Hernandez embarked on a strategy that focuses on the K-12 and early undergraduate years as the most important time period for ultimately attracting Latino students and underrepresented socio-economic groups to graduate education. His efforts include developing faculty-student partnerships at Georgia Institute of Technology as well as service on several NSF, National Research Council, and American Chemical Society projects aimed at enhancing diversity in the chemical workforce and in academia. Through these efforts, Professor Hernandez has attracted undergraduate students to work with him on his NSF-supported research in the area of chemical dynamics in non-stationary environments. Applications of his methodology are currently aimed at polymerization and protein folding. (See: http://www.chemistry.gatech.edu/rig/r_hernandez.html.)

The investigator's exemplary outreach and education efforts will help to attract Hispanic students to technical careers.

Increasing the participation of underrepresented groups in the mathematical sciences.

[0233785](#)

Funded under: PEOPLE
Award Title: University of Maryland Graduate Rewards Program
PI Name: Daniel Rudolph
Institution Name: University of Maryland College Park

The University of Maryland at College Park will work with a collection of affiliated colleges and universities to create a well-supported pathway to bring students from underrepresented groups to careers in the mathematical sciences. These affiliates include ones from which it has recruited students in the past and who share its philosophy of strong and complete academic and professional training. Currently Morehouse College, Bowie State University, Florida A&M University, North Carolina A&T, Spelman College, Trinity College of DC, and Xavier University are Affiliates. The institution is actively recruiting new Affiliates. An annual Affiliates Workshop will strengthen ties among these institutions and guide and maintain the effectiveness of this program. Sophomores and juniors will be recruited to participate in a Summer Institute at the institution. This Institute will provide both upper level undergraduate academic classes and research experiences to reinforce the students' training and maturity for graduate study. A Graduate Fellowship Program will offer competitive fellowships to graduates from the Affiliates. As Fellows in this program, students will be provided complete career training as mentors, educators and scientists. The Summer Institute will extend to the graduate level, offering academic training in preparation for qualifying and candidacy exams and integration with the department's Research Interaction Team (RIT) program. Graduate Assistantships will be offered to students to support the program. These Graduate Assistants will provide classroom support, tutoring, mentoring and advising for the Summer Institute. A supported Peer Mentoring Program will provide peer mentors to students in the mathematical sciences and will provide supported students with training for mentorship. Funding is for: fifteen undergraduate participants in the Summer Institute, three to four 4-year graduate fellowships per year, teaching assistantship support both preceding and during the Summer Institute, peer mentoring support, and both recruiting and workshop travel support.

This effort is meritorious in its effort as attempt to contribute to development of a diverse workforce through participation of underrepresented groups that is its stated goal. However it is a major detriment to the well-intentioned program that Hispanic and Native American groups are not amongst the universities targeted for the program.

[9600115](#)

Funded under: PEOPLE
Award Title: Supplement to LSAMP Award
PI Name: Louis Dale
Institution Name: University of Alabama at Birmingham

[9624189](#)

Funded under: PEOPLE
Award Title: AMP: California Alliance for Minority Participation in Science, Engineering and Mathematics (CAMP)
PI Name: Nicolaos Alexopoulos
Institution Name: University of California-Irvine

[0217629](#)

Funded under: PEOPLE
Award Title: Tennessee Louis Stokes Alliance for Minority Participation (TLSAMP)
PI Name: James Hefner
Institution Name: Tennessee State University

P2: Contributions to development of a diverse workforce through participation of underrepresented⁷ groups in NSF activities.

Retrospective analysis:

- *Has NSF demonstrated significant achievement for this indicator as a result of the outcomes of past awards? YES*

The projects and accomplishments presented in the retrospective analysis are drawn from a large variety of programs, many of which are making substantial contributions to the development of a diverse and competitive workforce of scientists and engineers. The examples range from very large investments targeted at achieving significant systemic impact to single investigator supplements that impact very small groups of individuals. All of these efforts have their significance and the existence of such a broad portfolio could be interpreted as a strategy whereby all the programs in the Foundation are to assume some level of responsibility for enhancing this particular indicator.

The Louis Stokes Alliances for Minority Participation (LSAMP) continues to be one of the most important programs, contributing to achievement in this indicator. Participation now extends to over 30 alliances representing over 400 individual institutions impacting over 206,000 underrepresented minority students. Clearly this program has had a significant impact on increasing participation by underrepresented groups in STEM activities and careers. Since some of the alliances have now reached the capstone phase in their development, data on the impact of this program on the production of PhD students may also soon be available. ([9702237](#); [9900796](#); [9623615](#); [0217571](#))

The commitment of NSF's Science and Technology Centers and Engineering Research Centers programs to research, education and outreach for underrepresented groups is also reflected in the examples provided in both the retrospective and prospective portfolios. These include the development of extensive summer research and educational programs and workshops for women and underrepresented minority students. Some of the more recent efforts also involve K-12 teachers through Research

⁷ Includes women, underrepresented minorities, or persons with disabilities.

Experiences for Teachers supplements and are targeted at inner city urban environments. Measurable results in terms of attracting underrepresented students into STEM careers are reported in practically all cases. ([9986866](#); [9529161](#))

The role of other major NSF programs in the development of a diverse workforce is also reflected in the examples in varying degrees. Many Presidential Early Career Awards for Scientists and Engineers and CAREER awardees involve women and underrepresented minorities in their programs, in these cases significant impacts are made on single individuals or small groups of individuals. VIGRE, or the Vertical Integration of Graduate Research and Education program aims to increase the number of U.S. citizens with PhD's in the mathematical sciences. It is now showing, through the third year review of its sites, quantifiable measures of progress in achieving its objectives. One of the more promising programs for this indicator is the relatively new Graduate Teaching Fellows in Education (GK-12) program. One example of a GK-12 site is the University of Pennsylvania "Access Science" program where the K-12 student population served by the program in West Philadelphia is 98 percent African American. While one would assume that other programs such as Experimental Program to Stimulate Competitive Research and the Advanced Technological Education program would also significantly impact this indicator, less evidence of this impact is provided in the portfolio.

One of the most outstanding activities in terms of the development of a diverse STEM workforce has been the implementation of the Research Experiences for Undergraduates (REU) concept across the Foundation, through REU sites, REU supplements, Collaborative RUI programs, or other mechanisms. The significance of this concept on this indicator is reflected throughout the examples. The interaction between minority institutions without graduate research programs and established research institutions has provided an excitement and synergy that has led, in some cases, to groundbreaking research results prompted by the involvement of the underrepresented students. ([0138640](#); [0139654](#); [0139527](#); [0139675](#); [9876771](#); [0137336](#))

Another important long-term investment for this indicator lies in those projects focused on developing valid, demonstrable strategies for strengthening K-12, and in particular K-6, education in regions with large underrepresented and economically disadvantaged populations. The four-year Valley Imperial Project in Science project is an excellent example of how NSF funding has achieved such an objective. Its scholarly peer-reviewed results provide a clear message of significant student achievement using a variety of accountability measures and represent a valid and significant model of how to bring quality science and mathematics education to students from these populations.

Another example of a large systemic initiative is provided through the Alaska Rural Systemic Initiative. Now in its 7th year of operation the program reports a number of benefits in the achievement and participation of Alaskan natives in STEM activities both at K-12 and higher education levels. Related projects include a cooperative agreement between the Alaska Native Science Commission and the Office of Polar Programs that facilitates connections between rural communities and NSF supported

research, outreach activities by the Artic Research Consortium in which women and underrepresented groups form the majority of the workforce, and involvement of Alaskan natives in anthropological studies in North Bering Straits societies. ([0086194](#); [0231085](#); [0101279](#); [0095120](#))

Mentoring activities continue to be an important part of this portfolio and are represented through examples of workshop and training grants aimed at developing women and minority faculty leaders in areas such as Chemistry and Chemical Engineering. Nonetheless, benchmarking studies continue to show the need to increase the participation of women and underrepresented faculty in many areas of science and engineering. Other studies represented in this portfolio highlight issues such as the impact of departmental practices in attrition rates of undergraduate women in computing majors as well trends indicating that women are finding non-traditional pathways into the IT workforce. All of these factors point to the challenge that NSF continues to face in the achievement of its goals relative to this indicator. ([0090083](#); [0097254](#))

[9731274](#)

Funded under: PEOPLE
Award Title: Valle Imperial - Project in Science
PI Name: Michael Klentschy
Institution Name: El Centro School District

The goal of the above project is to strengthen K-6 education in 16 school districts serving a region that experiences geographic isolation and poverty. The student body is 82% Hispanic and 47% limited language proficient. The project sought to increase student achievement through kit-based science programs. Results of a four-year study of K-6 students show significant results of student achievement under various well-documented measures of accountability.

[0090083](#)

Funded under: PEOPLE
Award Title: Minority CHE Faculty 2000+: A workshop to develop minority leaders in the CHE academy
PI Name: Christine Grant
Institution Name: North Carolina State University

[0097254](#)

Funded under: PEOPLE
Award Title: Advancing the Careers of Women Faculty in the Chemical Sciences
PI Name: Geraldine Richmond
Institution Name: University of Oregon Eugene

The first project above was a workshop to develop minority faculty leaders in Chemical Engineering. Over 60 aspiring minority faculty engaged with established minority faculty in mentoring and networking opportunities. A survey analysis was designed to evaluate the impact of the workshop and a website was developed.

The second project involved the implementation of training programs in communication, negotiation and leadership skills for women faculty in Chemistry and

Chemical Engineering. Over 100 women faculty have attended with 30 more anticipated in 2003.

[0000485](#)

Funded under: PEOPLE
Award Title: Zeolite-Supported Ruthenium Catalysts for Carbon Monoxide Hydrogenation Reaction
PI Name: Jale Akyurtlu
Institution Name: Hampton University

This collaborative RUI project involved a partnership between Hampton University, a Historically Black University with no graduate program, and the University of Virginia. Results include co-authored research publications and presentations by Hampton students and faculty and University of Virginia researchers.

[9986866](#)

Funded under: IDEAS
Award Title: An Engineering Research Center In Wireless Integrated Microsystems
PI Name: Kensall Wise
Institution Name: University of Michigan Ann Arbor

[9529161](#)

Funded under: IDEAS
Award Title: University of Washington Engineered Biomaterials (UWEB) Engineering Research Center
PI Name: Buddy Ratner
Institution Name: University of Washington

These ERC outreach programs above show significant results in providing pre-college and college opportunities to underrepresented groups. The first focuses on secondary schools with four summer programs designed to improve pre-college student skills in science, math, computer science and communications. Over 50 percent of the students are females and/or minorities. The second program had a higher percentage of minority graduate and undergraduate students (11%) than the university (7.1%) and its College of Engineering (4.7%).

[0138640](#)

Funded under: PEOPLE
Award Title: Research Experiences for Undergraduates in Chemistry: A Dispersed Site in Physical Organic Chemistry
PI Name: I. David Reingold
Institution Name: Juniata College

[0139654](#)

Funded under: IDEAS
Award Title: Research Experiences in Sociological Studies of Social Stratification and Racial and Ethnic Relations
PI Name: Rogelio Saenz
Institution Name: Texas A&M Research Foundation

[0139527](#)

Funded under: PEOPLE
Award Title: Research Experience for Undergraduates at Santa Clara University
PI Name: Julie Mueller
Institution Name: Santa Clara University

[0139675](#)

Funded under: PEOPLE
Award Title: REU Site: Consortium for Undergraduate Research Experience (CURE)
PI Name: Stephen Gillam
Institution Name: California State L A University Auxiliary Services Inc.

[9876771](#)

Funded under: PEOPLE
Award Title: STC: The Nanobiotechnology Center
PI Name: Barbara Baird
Institution Name: Cornell University - Endowed

[0137336](#)

Funded under: IDEAS
Award Title: RUI-Microbial Observatories: Diversity of Halophilic Bacteria and Geochemical Signatures in a Tropical Solar Saltern
PI Name: Lillian Casillas-Martinez
Institution Name: University of Puerto Rico at Humacao

The above are all examples of REU site projects that involve women and underrepresented minorities through either extensive multi-university collaboration or focused minority involvement. The Baird project also resulted in a minority REU student, Nancy Guillen, being recognized for her groundbreaking work in the research and development of a nano-filter for bio-medical lab-on-a chip applications.

[9702237](#)

Funded under: PEOPLE
Award Title: AMP: North Carolina Alliance for Minority Participation (NCAMP)
PI Name: Carolyn Meyers
Institution Name: North Carolina Agricultural & Technical State University

[9900796](#)

Funded under: PEOPLE
Award Title: AMP: Oklahoma State University
PI Name: Earl Mitchell
Institution Name: Oklahoma State University

[9623615](#)

Funded under: PEOPLE
Award Title: AMP: Western Alliance to Expand Student Opportunities
PI Name: Antonio Garcia
Institution Name: Arizona State University

[0217571](#)

Funded under: PEOPLE
Award Title: North Carolina Louis Stokes Alliance for Minority Participation - Phase III
PI Name: Carolyn Meyers
Institution Name: North Carolina Agricultural & Technical State University

In 2002, more than 21,429 underrepresented minority students received baccalaureate degrees in STEM fields through the Louis Stokes Alliance for Minority Participation (LSAMP) program. The program now has 30 alliances representing over 400 institutions. In 2003, the number of STEM students impacted by LSAMP will reach 206,893- an all-time high. The North Carolina LSAMP, which has been renewed for Phase III, graduated 841 minority BS STEM recipients in 2002 and has seen its minority enrollment increase from 4,774 in 1997 to 5,588 in 2001.

[0086194](#)

Funded under: PEOPLE
Award Title: Alaska Rural Systemic Initiative, Phase II
PI Name: Raymond Barnhardt
Institution Name: Alaska Federation of Natives

[0101279](#)

Funded under: PEOPLE
Award Title: Organizational Support to the U.S. Arctic Science Program
PI Name: Wendy Warnick
Institution Name: Arctic Research Consortium of the U.S.

[0095120](#)

Funded under: PEOPLE
Award Title: COLLABORATIVE RESEARCH-Change and Its Impact on Culture, Economy and Identity in Three North Bering Strait Alaskan Inupiat Societies: Little Diomedede Island, King Island, Wales
PI Name: Carol Jolles
Institution Name: University of Washington

[0231085](#)

Funded under: PEOPLE
Award Title: Alaska Native Science Commission
PI Name: Patricia Cochran
Institution Name: Alaska Native Science Commission

The first project above, the Alaska Rural Systemic Initiative, is now in its 7th year. Evaluations have shown benefits in student achievement, decreases in drop-out rates, increases in the number of rural students attending college, and increases in the number enrolling in STEM fields. The other projects are examples of impact on the Alaskan native population and/or the role of women and underrepresented minorities in research, education and outreach efforts related to this population.

Prospective analysis:

- *Comment on the potential future impact of new activities and awards.*

The portfolio of prospective examples provides documentation that indicates the potential for substantial future impact in this indicator. We now find new REU sites that are highly focused in terms of their underrepresented student population as well as projects aimed at significantly expanding the concept to create multi-university dispersed sites around a common scientific theme. A recently funded project for a workshop on Undergraduate Research Centers explores how a research experience can be brought to a

far larger and more diverse group of undergraduates at an earlier stage of their academic program ([0315117](#)). Contrary to the retrospective analysis, where the population of persons with disabilities was not addressed at all, new awards reflect that attention is now being provided to this population. ([0095948](#); [0079114](#))

One of the concerns in the previous assessment for this indicator was that there was more focus on college and post-college activities and that pre-college only came into view with informal science activities. The portfolio presented for this assessment still reflects this imbalance although a number of encouraging pre-college examples such as the expansion of the ASTRO site program to include families of all backgrounds does start to address the concern for parent engagement in the pre-college experience of minority students. ([0132798](#)).

Another major effort developed by NSF to address this indicator is the Model Institutes for Excellence (MIE) program. During its first two phases this program funded four institutions to develop and refine models for increasing graduates in STEM disciplines. The objective of the third phase is to determine the success of the models that have been developed and to gauge the success or failure of institutionalizing these models. Inclusion of this program in future analysis will provide a valuable indicator of the future impact of programs that have been developed to specifically address this indicator.

[0315117](#)

Funded under: PEOPLE
Award Title: A Workshop on the Concept of Creating Undergraduate Research Centers in Chemistry; March 31-April 2, 2003; Arlington, VA
PI Name: Jeanne Pemberton
Institution Name: University of Arizona

The objective of this workshop was to explore how the concept of Research Experiences for Undergraduates can be brought to a far larger, more diverse group of undergraduates at an earlier stage of their academic program through the creation of an NSF Undergraduate Research Centers program.

[0231923](#)

Funded under: PEOPLE
Award Title: GK-12 Access Science: Today's teachers and tomorrow's scientists teaching and learning together
PI Name: Dennis DeTurck
Institution Name: University of Pennsylvania

This GK-12 program, Access Science, provides undergraduate and graduate fellowships to enhance teaching resources and capabilities for K-12 students in West Philadelphia. The program serves a student population that is 98% African-American.

[0095948](#)

Funded under: PEOPLE
Award Title: Clearinghouse on Mathematics, Engineering, Technology and Science
PI Name: Harry Lang
Institution Name: Rochester Institute of Tech

[0079114](#)

Funded under: IDEAS
Award Title: Polymer Surface Chemistry: Structure and Reactivity of Polymer Monolayers, Polymer Surface Segments and Oligomeric Chain Distributions
PI Name: Joseph Gardella
Institution Name: SUNY at Buffalo

The first project seeks to develop a web-based clearinghouse of STEM materials to improve academic readiness of deaf and hearing-impaired students. Collaborations with China and Japan are part of a goal of eventually establishing a worldwide university network serving deaf students. The second project is a collaboration with design and occupational therapy units on the PI's campus to enable a disabled student to pursue a PhD in Chemistry.

[0132798](#)

Funded under: TOOLS
Award Title: AURA Management and Operations of the National Optical Astronomy Observatory and the National Solar Observatory
PI Name: William Smith
Institution Name: AURA/National Optical Astronomy Observatories

The Family ASTRO Site program aims to bring hands-on astronomy to families of all backgrounds. This particular grant targets families of Hispanic and American Indian background.

Summary:

NSF is to be congratulated for its many programs at all levels that strive to provide our nation with a diverse and competitive science and engineering workforce. While there remains room for improvement, its efforts to engage administrators, faculty, and students at all levels in this objective have produced significant results. The challenge faced by the Foundation is the sustainability of current programs that have this indicator as their primary focus as well as the enhancement of all the programs in its portfolio. Contrary to other performance measures, every single program in the Foundation has an opportunity to impact this indicator. It is recommended that future assessments reiterate and recognize this potential and use it as the measuring bar for NSF's success in this critical aspect of its mission.

P3: Development or implementation of other notable approaches or new paradigms⁸ that promote progress toward the PEOPLE outcome goal.

Retrospective analysis:

- *Has NSF demonstrated significant achievement for this indicator as a result of the outcomes of past awards? YES.*

The NSF portfolio contains important examples of education and research programs that are designed to enable students, educators and researchers to explore the challenges of science, technology, engineering and mathematics and related fields. Overall there is a balance of programs supporting learning and exploration at the K-12 level; teacher and faculty development activities; curriculum development and dissemination activities for the K-12 and college classrooms; mass media, print and web-based public awareness activities; and activities to encourage women and underrepresented minorities to develop interest in and pursue STEM careers.

A visual interface tool has been developed for **children**, ages 3-13, to help them query, browse and organize multimedia information from an international collection of over 10,000 digital children's books. A PBS broadcast program featuring children, ages 9-12, engaged in scientific investigation, modeled the inquiry experience for millions of children and adults. Supported by the web and publications, the television programs appear to have increased student interest in science and mathematics as well as parental involvement in science and mathematics education:

[0205082](#)

Funded under: PEOPLE
Award Title: ITR: Developing a Children's International Digital Library
PI Name: Allison Druin
Institution Name: University of Maryland College Park

[9909086](#)

Funded under: IDEAS
Award Title: DLI-Phase 2: Digital Libraries for Children
PI Name: Allison Druin
Institution Name: University of Maryland College Park

[0125738](#)

Funded under: PEOPLE
Award Title: DragonflyTV, Seasons Two and Three
PI Name: Richard Hudson
Institution Name: Twin Cities Public Television

[9909828](#)

Funded under: PEOPLE
Award Title: DragonflyTV: A New Science Show for Children
PI Name: Richard Hudson
Institution Name: Twin Cities Public Television

⁸ For example, broad-based, program-wide results that demonstrate success related to improved math and science performance for preK-12 students, or professional development of the STEM instructional workforce, or enhancement of undergraduate curricular/laboratory/instructional infrastructure, or highly synergistic education and research activities, or international collaborations, or communication with the public regarding science and engineering.

NSF funding has supported **curriculum development** in a number of areas including: (a) an introductory-level, interdisciplinary course and textbook in bioinformatics; (b) an environmentally-benign ('green') organic chemistry course and laboratory experiments; (c) a new approach to teaching power electronics and electric drives which has been adopted by 21 universities; and (d) a culturally-situated design tool that uses mathematics practice embedded in artifacts such as hairstyles, beadwork, and rhythm patterns in music to teach students how their cultural background can become a bridge to information technology careers:

[0122582](#)

Funded under: PEOPLE
Award Title: EI: Crossing the Interdisciplinary Barrier: An Integrated Undergraduate Program in Bioinformatics
PI Name: Michael Raymer
Institution Name: Wright State University

[0088986](#)

Funded under: PEOPLE
Award Title: An Environmentally-benign ('Green') Organic Chemistry Curriculum
PI Name: James Hutchison
Institution Name: University of Oregon Eugene

[0218077](#)

Funded under: PEOPLE
Award Title: Faculty Workshop on Teaching of First Course on Power Electronics, Electric Drives and Power Systems Applications of Power Electronics; Arizona State University; January 2-4, 2003
PI Name: Rajapandian Ayyanar
Institution Name: Arizona State University

[0119880](#)

Funded under: TOOLS
Award Title: ITWF: Culturally Situated Design Tools
PI Name: Ron Eglash
Institution Name: Rensselaer Polytechnic Institute

The portfolio contains many examples of **teacher professional development** activities ranging from a weekly newspaper containing original stories from the Antarctic about science, to the use of an observatory's high-speed Internet link that connects twin telescopes in two hemispheres to facilitate teacher exchange activities; to the use of video and data links in teacher professional development in elementary schools involving a partnership of higher education, intermediate and local educational agencies, and private sector supporters of science education.

Noteworthy among teacher development projects is the Detroit Urban Systemic Program that assists the district in implementing K-12 science and mathematics standards based on the Michigan Core Curriculum. The program is a collaborative effort with local universities that provide courses, coaching, team teaching, modeling and demonstration lessons for 2,700 teachers of science and mathematics.

The **research** portfolio is rich and varied. In the area of multi-lingual speech translation and communication, research has produced a system that enables users to connect with a “commercial” service provider that speaks a different language and receive detailed information via a live video-conferencing channel, in which speech translation is embedded. Germany, France, Italy and the U.S support the project:

[9982227](#)

Funded under: IDEAS
Award Title: MLIAM: NESPOLE! - Negotiating through Spoken Language in E-commerce
PI Name: Alexander Waibel
Institution Name: Carnegie-Mellon University

Research on the uses of supercritical carbon dioxide in innovative processes has led to environmentally friendlier processes and reduced pollution in the manufacture of polymers and in commercial dry cleaning. K-12 mathematics and science teachers are recruited to develop novel curriculum tools for K-12 education and create engaging exhibits for the North Carolina Museum of Science Students based on research. Two industries have made extensive use of the research:

[0120613](#)

Funded under: PEOPLE
Award Title: MPS Internships in Public Science Education - MPS-IPSE: Carbon Dioxide in Nature and Technology: Internships in Public Education
PI Name: Ruben Carbonell
Institution Name: North Carolina State University

[9876674](#)

Funded under: IDEAS
Award Title: Center for Environmentally Responsible Solvents and Processes
PI Name: Joseph DeSimone
Institution Name: University of North Carolina at Chapel Hill

Prospective analysis:

- *Comment on the potential future impact of new activities and awards.*

The portfolio of recently funded projects contains examples of approaches designed to promote better understanding of science, increase interest of women and minorities in science fields, provide resources for science educators and help develop the workforce of tomorrow.

The Polymer Science of Everyday Things (cooking with plastics, polymers in food, wound care, diapers, etc.), a “Presidential Symposium” at the March, 2003 American Chemical Society Meeting, is an example of **outreach to the public**. It was organized with the British Royal Society and webcast to a number of U.S. universities:

[0306317](#)

Funded under: IDEAS
Award Title: Partial Support for the ACS Polymer Division Symposium: The Polymer Science of Everyday Things; New Orleans, LA; March 22-24, 2003
PI Name: Kenneth Wynne
Institution Name: Virginia Commonwealth University

Three 90-minute primetime public television programs, supported by an interactive website and neighborhood workshops and coalitions organized by local PBS stations, are being developed to increase awareness of environmental issues and public health:

[0205382](#)

Funded under: PEOPLE
Award Title: Journey to Planet Earth: An Annual Report
PI Name: Marilyn Weiner
Institution Name: SCREENSCOPE, Inc.

Over the next three years, 624 television segments that present current, ongoing research in nanotechnology, genetics/genomics, ocean sciences, global climate changes and brain sciences will be produced and broadcast on ABC and NBC stations:

[0206184](#)

Funded under: PEOPLE
Award Title: Commercial Television News as a Vehicle for Enhancing Public Understanding of Research (PUR)
PI Name: Eliene Augenbraun
Institution Name: ScienCentral Incorporated

The examples provided include two approaches for **evaluating effectiveness of NSF-funded** programs. One project is developing and testing a technique for determining which interventions are most effective in increasing the diversity of the workforce. NIH, NSF and the GE Fund will participate in developing the model. The other evaluation study will develop a framework for documenting student achievement in math attributable to curricula developed by NSF:

[0231644](#)

Funded under: PEOPLE
Award Title: Building Evaluation Capacity from the Inside Out: A Model for Funding Agencies
PI Name: Beatriz Clewell
Institution Name: Urban Institute

[0102582](#)

Funded under: PEOPLE
Award Title: High Quality Science, Mathematics, Engineering and Technology Education for All Learners
PI Name: Michael Feuer
Institution Name: National Academy of Sciences

NSF has funded a number of novel curriculum development activities and approaches that have potential for improving classroom instruction. For example, students in the Los Angeles Unified School District will be introduced to state-of-the-art ocean science by Master Teachers previously trained in an NSF teacher enhancement program. Students at a tribal college and a mainstream university will be offered a general ecology course developed specifically to integrate traditional ecological knowledge and science of ecology. This course, taught on both campuses, may increase the numbers of Native Americans in science disciplines while introducing students at the main stream university to approaches of traditional ecological knowledge:

[0215497](#)

Funded under: PEOPLE
Award Title: Collaborative: COSEE-West
PI Name: Anthony Michaels
Institution Name: University of Southern California

[0231139](#)

Funded under: PEOPLE
Award Title: Collaborative Research: Education Materials to Bring Traditional Ecological Knowledge into Science Education
PI Name: Robin Kimmerer
Institution Name: SUNY College of Environmental Science and Forestry

Participation in undergraduate research is widely recognized as a key determinant in encouraging students to pursue careers in technical fields. Illustrative of NSF's support of undergraduate research is the Research Apprentice Program at the University of Illinois which targets ethnic minority students and students from non-traditional schools interested in pursuing careers in Agriculture and Veterinary sciences. The laboratory in which these students work collaborates with scientists in Japan thus exposing students to scientists from different cultures.

[0238451](#)

Funded under: PEOPLE
Award Title: CAREER: Methanosarcina Acetivorans as a Model to Elucidate the Mechanism of DNA Replication in the Archaea
PI Name: Isaac Cann
Institution Name: University of Illinois at Urbana-Champaign

GOAL III-1b: NSF will significantly enhance the quality of K-12 mathematics and science education available to all students in Math and Science Partnership Schools.

P4: Evidence in the award portfolio of the infrastructure to support high quality programs addressing issues related to teacher workforce capacity, including preservice education and inservice professional development of math and science teachers as well as alternative routes into the profession (e.g., scientists and engineers becoming teachers).

Retrospective analysis:

- ***Has NSF demonstrated significant achievement for this indicator as a result of the outcomes of past awards? Program is too new. Not enough information to make a judgment.***

This is a new initiative for NSF with the first awards granted in fall 2002. Consequently, the portfolio is limited and materials substantiating and documenting achievement (or the lack of one) are insufficient. In its inaugural year NSF funded seven awards to Comprehensive projects. There are early indications based on the awards given last fall, that the “infrastructure to support high quality programs addressing issues related to teacher workforce capacity, including pre-service education and in-service professional development of math and science teachers as well as alternative routes into the profession” is being addressed by the funded programs. The three-year *Building Evaluation Capacity of STEM Projects* provides assistance to MSP projects and their stakeholders in designing and implementing context-sensitive, user-friendly evaluation approaches, as well as in developing and sustaining a culture of evidence that supports decision-making based on data. The MSP awarded programs are expected to improve student success and teacher capacity and quality in science and mathematics in the future. A major component of the Math and Science Partnership program is the implementation of change in mathematics and science education practices in both higher education and in K-12, to result in improved student achievement across the K-12 continuum. Several of the funded projects aim to improve teachers’ content knowledge and ability to use effective pedagogical strategies that ensure student learning. Good examples are Award No. 0139378 which addresses improvement of elementary, K-6, science program in twelve participating school districts in San Diego Award No. 0227028 addressing the achievement gap in science, mathematics, and technology education in central Appalachia, and Award No. 0227124 that addresses student achievements in science and mathematics Pre K-12 in three urban and nine rural school districts in El Paso, TX. One of these programs involves graduate students actively involved in partnership with teachers in the school districts and researchers at the university. All of these programs have just started and there is insufficient information at this time to conclude that together they constitute a portfolio that demonstrates significant achievement. The Committee has, as a matter of information, included one link below.

[0139378](#)

Funded under: PEOPLE
Award Title: GK12: Partnerships Involving the Scientific Community in Elementary Schools (PISCES): Graduate Teaching Fellowships in K-12 Education
PI Name: Walter Oechel
Institution Name: San Diego State University Foundation

Prospective analysis:

There are a number of funded programs that support and endorse different strategies underpinning this indicator: a strategy to improve achievement in mathematics, engagement of disciplinary faculty K-12, infrastructure to address teacher workforce capacity, inner city school enrichment, reaching all K-12 students, and scaling up while

focusing on teaching and learning. NSF has the opportunity to have a strong impact on K-12 student achievement in science and mathematics through the MSP program that aims to support and study innovative approaches that engage significant numbers of higher education faculty members in intensive work with their K-12 colleagues. Dissemination of these practices in which the higher education and K-12 partners unite efforts to improve student performance has a potential of achieving greater and more significant impact. The roles of disciplinary faculty in MSP projects are expansive. They include recruitment of undergraduate mathematics and science majors into the teaching profession, assistance to districts and schools in evaluating the content of instructional and assessment materials, and the modeling in university courses of pedagogies that are consonant with the existing evidence on effective teaching and learning. It is estimated that the initial impact of these partnerships addressing professional development of teachers is approximately 50,000 teachers. Over time, these prospective examples should yield results that will help inform judgments about NSF's performance.

Award ([0226948](#)) supports a program that will provide 150 research-based professional development hours to elementary and middle school teachers to improve their content knowledge in mathematics, and ultimately, improve students' success in Algebra I, a gatekeeper course in K-12. As part of this program grade level tests addressing conceptual learning will be created and piloted. Awards such as ([0227325](#)) and ([0227128](#)) support the partnership efforts of university science and mathematics faculty with K-12 teachers and pre-service students.

[0226948](#)

Funded under: PEOPLE
 Award Title: Mathematical ACTS
 PI Name: Richard Cardullo
 Institution Name: University of California-Riverside

[0227325](#)

Funded under: PEOPLE
 Award Title: Vertically Integrated Partnerships K-16 (VIP K-16)
 PI Name: Nancy Shapiro
 Institution Name: University System of Maryland

[0227128](#)

Funded under: PEOPLE
 Award Title: Texas Middle and Secondary Mathematics Project
 PI Name: Jasper Adams
 Institution Name: Stephen F. Austin State University

P5: Evidence within Partnership school systems of the infrastructure needed to improve mathematics and science education and to measure improvement, i.e., the adoption of appropriate assessments of student achievement, as well as the initiation of the collection of achievement data that can be disaggregated by ethnicity, socioeconomic status, gender, etc.

Retrospective analysis:

- *Has NSF demonstrated significant achievement for this indicator as a result of the outcomes of past awards? Program is too new. Not enough information to make a judgment.*

The first MSP awards were made in September 2002. Consequently, there is not enough information to determine whether there has been significant achievement for this indicator. However, the Committee notes that NSF has funded similar partnerships before and some of those partnerships are still ongoing. The Committee would have preferred to have those partnerships included in this indicator so that a more concrete assessment could have been made regarding NSF's contribution to improving the performance of K-12 students in mathematics and science. Based on the MSP awards made, however, the committee feels that attempts are being made to improve student performance and that in the future there will be information to document the level of improvement achieved. (See Awards: [0226989](#) and [0227028](#))

For example, the New Jersey Math Science Partnership ([0226989](#)) involves twelve school districts with a total of 75,000 students. Twenty seven percent of the students are African Americans and 31 percent are Hispanic. This partnership will increase achievement and reduce achievement gaps in mathematics and science for all preK-12 students. It also aims to increase and sustain the number, quality and diversity of preK-12 teachers in mathematics and science. Documentation of outcomes will include analysis of changes in student achievements.

Another example is the Appalachian Mathematics and Science Partnership ([0227028](#)) that involves 38 central and eastern Kentucky school districts, and 10 institutions of higher education. The total student population among all the partnering schools is 170,000. This partnership will reform science, mathematics and technology education in order to address the achievement-gap issue. It will also develop ways to produce a diverse and high quality mathematics and science teacher workforce.

Prospective analysis:

Under the MSP Learning Network, NSF makes awards for Comprehensive and Targeted Partnerships as well as awards for Research, Evaluation and Technical Assistance. Collectively, these awards produce a network of researchers and teachers that strive to understand and evaluate how students learn mathematics and science. The

goal is to disseminate successful approaches in order to benefit as many researchers and practitioners as possible.

Approximately 1.6 million K-12 students will be impacted through 24 MSP Comprehensive and Targeted awards made in 2002. There is a rich body of baseline information concerning the performance of students in 300 school districts. The partnership projects will provide valuable benchmarks that will serve to evaluate the student achievement in mathematics and science.

[0237653](#)

Funded under: PEOPLE
Award Title: Building from the Research: Envisioning Quality Science Assessments
PI Name: Pasquale DeVito
Institution Name: National Academy of Sciences

[0233472](#)

Funded under: PEOPLE
Award Title: MSP-Network: A Technical Assistance Design Project
PI Name: Joni Falk
Institution Name: TERC Inc

[0233382](#)

Funded under: PEOPLE
Award Title: Building Evaluation Capacity of STEM Projects
PI Name: Blaine Worthen
Institution Name: Utah State University

[0227303](#)

Funded under: PEOPLE
Award Title: Teachers Assisting Students to Excel in Learning Mathematics (TASEL-M)
PI Name: David Pagni
Institution Name: California State University-Fullerton Foundation

IDEAS OUTCOME GOAL: DETAILED ASSESSMENT OF PERFORMANCE

NSF OUTCOME GOAL FOR IDEAS: ENABLING “DISCOVERY ACROSS THE FRONTIER OF SCIENCE AND ENGINEERING, CONNECTED TO LEARNING, INNOVATION, AND SERVICE TO SOCIETY.”

NSF’s performance for the IDEAS Strategic Outcome is successful when, in the aggregate, results reported in this period demonstrate significant achievement in the majority of the following indicators:

I1: Discoveries that expand the frontiers of science, engineering, or technology.

Retrospective analysis:

- *Has NSF demonstrated significant achievement for this indicator as a result of the outcomes of past awards? YES.*

The Committee was impressed by the importance of the research findings, the degree to which the research frontiers crossed traditional disciplinary boundaries, and the breadth of discoveries. Examples include new findings in brain cell research, a Nobel prize for Bose-Einstein condensate, research uncovering order in Chaos, which led to the Japan prize, high energy physics research that resulted in the American Physical Society's prestigious Panofsky award, a multidisciplinary study on understanding earthquake behavior, cognitive science research into the creation of false memories in children, anthropological research on fertility control in China, and a sociological study of incarceration and its impact on family.

[9817252](#)

Funded under: IDEAS
Award Title: Photoperiodic and Neuroendocrine Regulation of Brain Plasticity
PI Name: Eric Bittman
Institution Name: University of Massachusetts Amherst

[0203203](#)

Funded under: PEOPLE
Award Title: Fractal Geometry: Summer Workshops and Other Outreach
PI Name: Benoit Mandelbrot
Institution Name: Yale University

[0104087](#)

Funded under: IDEAS
Award Title: Applications of Nonlinear Dynamics
PI Name: James Yorke
Institution Name: University of Maryland College Park

[0139984](#)

Funded under: IDEAS
Award Title: The Quantum Mechanical Many-Body Problem and Statistical Mechanics
PI Name: Elliott Lieb
Institution Name: Princeton University

[0098826](#)

Funded under: IDEAS
Award Title: Experimental Physics Research Program at Columbia University/Nevis Laboratories:
GROUP PROPOSAL
PI Name: P. Michael Tuts
Institution Name: Columbia University

[0204877](#)

Funded under: TOOLS
Award Title: The ATLAS Research Program: Empowering U.S. Universities
PI Name: William Willis
Institution Name: Columbia University

[9813752](#)

Funded under: IDEAS
Award Title: Friction from Atomic to Tectonic Scales
PI Name: Jean Carlson
Institution Name: University of California-Santa Barbara

[9730143](#)

Funded under: IDEAS
Award Title: Children's Spontaneous False Memories for Traumatic Medical Experiences
PI Name: Charles Brainerd
Institution Name: University of Arizona

[0003918](#)

Funded under: IDEAS
Award Title: The Chinese Demographic Transition: The Case of Xiaoshan, Zhejiang Province
PI Name: Stevan Harrell
Institution Name: University of Washington

[0004336](#)

Funded under: IDEAS
Award Title: The Impact of Incarceration on Family Formation: The Fragile Families and Child Well-being Study
PI Name: Bruce Western
Institution Name: Princeton University

Prospective analysis:

Surprise and serendipity in scientific discovery coupled with the growing interrelations between disciplines demands that NSF provide support widely across diverse fields of science. Our review of the prospective portfolio indicates that NSF's current investments are well positioned to enable wider impact and continued scientific advances. Some examples include integration of computers and protein function, decontamination of biological and chemical agents, combining neural and quantum computing, resource management, the Internet and workforce issues and the resolution of ethnic-based conflict.

[0225656](#)

Funded under: IDEAS
Award Title: Computational Learning and Discovery in Biological Sequence, Structure and Function Mapping
PI Name: Raj Reddy
Institution Name: Carnegie-Mellon University

[0225636](#)

Funded under: IDEAS
Award Title: ITR: Collaborative Research: Computational Learning and Discovery in Biological Sequence, Structure and Function Mapping
PI Name: Judith Klein
Institution Name: University of Pittsburgh

[0225609](#)

Funded under: IDEAS
Award Title: ITR: Collaborative Research - Computational Learning and Discovery in Biological Sequence, Structure and Function Mapping
PI Name: Jonathan King
Institution Name: Massachusetts Institute of Technology

[0241102](#)

Funded under: IDEAS
Award Title: Computational and Mathematical Study in Protein Interactions and Functions
PI Name: Fengzhu Sun
Institution Name: University of Southern California

[0076648](#)

Funded under: IDEAS
Award Title: Comparative Theoretical and Experimental Studies of Breakup, Outgassing and Stress-Induced Cavitation of Newtonian and Polymerically Thickened Liquids
PI Name: Daniel Joseph
Institution Name: University of Minnesota-Twin Cities

[0201995](#)

Funded under: IDEAS
Award Title: Theoretical and Experimental Investigation of Quantum Neural Computing
PI Name: Elizabeth Behrman
Institution Name: Wichita State University

[0241509](#)

Funded under: IDEAS
Award Title: Optimal Harvesting of Timber: Valuing Timberland with Stochastically Evolving Timber Volume and Prices Using Linked Biological/Geographical Data from British Columbia
PI Name: John Rust
Institution Name: National Bureau of Economic Research Inc

[0239538](#)

Funded under: IDEAS
Award Title: CAREER: Empirical Studies of Labor Market Intermediation
PI Name: David Autor
Institution Name: National Bureau of Economic Research Inc

[0240852](#)

Funded under: IDEAS
Award Title: Agent-Based Models of In-Group Favoritism and Out-Group Hostility
PI Name: Robert Axelrod
Institution Name: University of Michigan Ann Arbor

I2: Connections between discoveries and their use in service to society.

Retrospective analysis:

- *Has NSF demonstrated significant achievement for this indicator as a result of the outcomes of past awards? YES.*

A review of the summaries clearly indicates that NSF funding has enabled researchers to collaborate and produce a broad range of research findings that will improve the quality of life for peoples of the world. The seven project summaries chosen for illustrative purposes, from a group of 104 projects, have made discoveries that provide significant service to society. These range from projects with important climate implications including glacier studies and Antarctic ice sheets, to improving the lead time for severe weather forecasts, to the development of insecticides without harmful environmental effects and the use of spider venom toxins which affect insects but not mammals, to the preservation of Alaskan native artifacts, to new insights in vocational training of metalworkers.

The study of paleoclimates from glacier ice cores represents the discovery of new insights that enable a broader understanding of the interaction of climate and society.

[9910172](#)

Funded under: IDEAS
Award Title: Ice Core Paleoclimate Study of East African Monsoon and ENSO Variability from the Ice Fields of Kilimanjaro
PI Name: Lonnie Thompson
Institution Name: Ohio State University Research Foundation

A project that demonstrates how discoveries have the potential to revolutionize the control of insect damage to crops and increase the food supply of a growing human population.

[0131328](#)

Funded under: IDEAS
Award Title: Effect of a Unique Maize Defense Proteinase on Caterpillar Midgut Structure
PI Name: Dawn Luthe
Institution Name: Mississippi State University

A critical societal need is to improve the reliability of forecasts of severe weather and flash floods in order to prevent loss of life and mitigate economic losses. Results from this collaborative project will substantially increase the lead time for flash flood warnings from an hour to several hours, saving lives and reducing damage to property.

[0121048](#)

Funded under: IDEAS
Award Title: Mesoscale Studies of Convection, Tornadogenesis and Fronts
PI Name: Roger Wakimoto
Institution Name: University of California-Los Angeles

[0208651](#)

Funded under: IDEAS
Award Title: Collaborative Research: Doppler on Wheels International H2O Project Participation and Studies of Convective Initiation
PI Name: Yvette Richardson
Institution Name: Pennsylvania State Univ University Park

[0129892](#)

Funded under: IDEAS
Award Title: Optimal Utilization and Impact of Water Vapor and Other High Resolution Observations in Storm-Scale Quantitative Precipitation Forecasts (QPF)
PI Name: Ming Xue
Institution Name: University of Oklahoma Norman Campus

A project will help forecast the future stability of the West Antarctic ice sheet, which potentially could have a major climatic impact if deglaciation continues.

[9909778](#)

Funded under: IDEAS
Award Title: Retreat History of the West Antarctic Ice Sheet, Marie Byrd Land
PI Name: John Stone
Institution Name: University of Washington

A project that ensures the preservation of an important artifacts collection at risk from being lost and brings together the Aleut people with their cultural heritage through new analyses of archaeological materials and their repatriation to their ancestral home in Alaska.

[0137756](#)

Funded under: IDEAS
Award Title: SGER: Proposal to Analyze, Catalogue, and Return to Alaska Materials from the Hot Springs Village Site Currently in Sapporo, Japan
PI Name: Herbert D.G. Maschner
Institution Name: Idaho State University

Through a study of the molecular structure of spider venom neurotoxins, researchers have identified some which selectively target the nervous system of insects but do not affect mammalian nervous systems. The researchers foresee several ways in which the insect-specific neurotoxins may be used in agriculture that would reduce the dependency on chemical pesticides.

[9983243](#)

Funded under: IDEAS
Award Title: Structure-Function Studies of Novel Insecticidal Toxins
PI Name: Glenn King
Institution Name: University of Connecticut Health Center

Research that identified the dissonance between employer expectations for job skills and the training received in vocational education and its impact on the metal working industry.

[9996220](#)

Funded under: IDEAS
Award Title: A Comparison of Training Options for Machine-Tool Workers
PI Name: Garry Chick
Institution Name: Pennsylvania State Univ University Park

Prospective analysis:

From a collection of 37 projects that will likely have future benefits to society, three were chosen as indicative of the range of these efforts in the fields of urbanization, novel aircraft engines and climate change.

A study on the effect of urbanization on the formation of trace gases that affect climate is being conducted via an interdisciplinary collaboration of atmospheric scientists, social scientists, urban planners, and ecologists. The investigators plan to study the influences of urban land cover on air quality and greenhouse gas emissions. Decision-makers from local governments will participate and this partnership between university researchers and local government will be evaluated by social scientists.

[0215768](#)

Funded under: IDEAS
Award Title: BE/CNH: Urban Trace-gas Emissions Study (UTES): Interactions Among Canopy Processes, Anthropogenic Emissions, and Social Institutions in the Salt Lake Valley, Utah
PI Name: Diane Pataki
Institution Name: University of Utah

If aircraft engines could be mounted internally, the reduced drag or friction would decrease fuel consumption. An internal air inlet would require the air to make a turn before entering the engine, resulting in poor engine performance. Recent technological advances in high performance computing and optimization software have resulted in innovative new designs for submerged inlets. Computer simulations indicate that a slight change in internal shape of the air inlet yields an appreciable decrease in airflow distortion. This work could potentially revolutionize the shape and efficiency of aircraft of the future.

[0121058](#)

Funded under: IDEAS
Award Title: ITR: Data Driven Design Optimization in Engineering Using Concurrent Integrated Experiment and Simulation
PI Name: Doyle Knight
Institution Name: Rutgers University New Brunswick

Scientists have recently determined that two major West Antarctic ice streams show strong but distinct tidal signals with motion being limited to two brief periods each

day. Knowledge of ice stream behavior gained from this field study will contribute to assessment of the potential for rapid ice-sheet change, which could affect global sea level with societal consequences.

[0226535](#)

Funded under: IDEAS
Award Title: Collaborative Research: Characterizing the Onset of Ice Stream Flow: A Ground Geophysical Field Program
PI Name: Sridhar Anandakrishnan
Institution Name: Pennsylvania State Univ University Park

I3: Partnerships that enable the flow of ideas among the academic, public or private sectors.

Retrospective analysis:

- *Has NSF demonstrated significant achievement for this indicator as a result of the outcomes of past awards? YES.*

NSF support has provided the basis for an array of partnerships that have contributed to its outcome goal of enabling discovery at the frontier of science and engineering, connected to learning, innovation, and service to society. These partnerships have influenced the content of research agendas, made possible research undertakings that would otherwise not have been possible, increased the likelihood that research findings will contribute to societal benefits in the public and private sectors, benefited from and contributed to improved international collaboration and forged closer linkages between research and education.

The dominant forms of these partnerships, as illustrated by the examples below are:

- ✓ international collaboration between U.S. scientists and research institutions and scientists and research organizations in other countries;
- ✓ interdisciplinary collaboration among scientists in different fields across multiple institutions;
- ✓ collaboration between university scientists and public sector organizations that integrate basic and applied research directed at specific national, state or local government problems;
- ✓ collaboration between and among universities, government agencies and the private sector directed at integrating research and educational experiences for students.

([0098549](#) - Stellar relic in Milky Way), ([9981552](#) - Curbing Chagas disease), ([9870720](#) – - IGERT- Smart Sensors), ([0010062](#) - Nano materials), ([9978318](#) - Fire hazard estimation), ([9982227](#) - Negotiating through spoken language in e-commerce)

[0098549](#)

Funded under: IDEAS
Award Title: The Nature of Metal-Poor Carbon-Enhanced Stars in the Galaxy
PI Name: Timothy Beers
Institution Name: Michigan State University

[9981552](#)

Funded under: IDEAS
Award Title: Mathematical Models of Selection and Interaction Among Populations
PI Name: Joel Cohen
Institution Name: Rockefeller University

[9870720](#)

Funded under: IDEAS
Award Title: IGERT FORMAL PROPOSAL:Smart Sensors and Integrated Devices
PI Name: Gregory Auner
Institution Name: Wayne State University

[0010062](#)

Funded under: IDEAS
Award Title: NSF-EC Activity: Nanometer Scale Induced Structure Between Amorphous Layers and Crystalline Materials
PI Name: W. Craig Carter
Institution Name: Massachusetts Institute of Technology

[9978318](#)

Funded under: PEOPLE
Award Title: Fire Hazard Estimation Using Point Process Methods
PI Name: Frederic Schoenberg
Institution Name: University of California-Los Angeles

[9982227](#)

Funded under: IDEAS
Award Title: MLIAM: NESPOLE! - Negotiating through Spoken Language in E-commerce
PI Name: Alexander Waibel
Institution Name: Carnegie-Mellon University

Prospective analysis:

Partnerships are making possible cutting edge research on important scientific and societal issues as shown in the examples. These partnerships are found between universities, public and private sector organizations:

([0210332](#) - Nanoscale biological sensors), ([0221274](#) - Green chemistry),
([0240310](#) - Predicting avalanches)

[0210332](#)

Funded under: IDEAS
Award Title: NIRT: Development, Functionalization, and Assembly of Nanoscale Biological Sensors
PI Name: Seunghun Hong
Institution Name: Florida State University

[0221274](#)

Funded under: PEOPLE
Award Title: Pan-American Advanced Studies Institute on Green Chemistry; Montevideo, Uruguay, July 6-17, 2003
PI Name: Mary Kirchoff
Institution Name: American Chemical Society (ACS)

[0240310](#)

Funded under: IDEAS
Award Title: Temporal Changes in the Spatial Variability of Snow Stability
PI Name: Katherine Hansen
Institution Name: Montana State University

I4: Leadership in fostering newly developing or emerging areas.

Retrospective analysis:

- ***Has NSF demonstrated significant achievement for this indicator as a result of the outcomes of past awards? YES.***

There is a broad range of developing and/or emerging activities that are taking place under NSF leadership. These research and education activities occur across and among many scientific fields. NSF uses workshops as well as centers (e.g, physics frontier centers) to bring researchers together to identify, seed, and bring coherence to important new research areas. Examples of important research areas are listed below:

The development of a computer model to accurately predict how E. coli adapts and evolves when placed under environmental constraints has resulted in identifying strains that may be more efficient at producing insulin or cancer-fighting drugs than existing bacterial colonies engineered by researchers using standard techniques. ([0120363](#) - Kinetic and Regulatory Constraints on Metabolism)

[0120363](#)

Funded under: IDEAS
Award Title: QSB: Kinetic and Regulatory Constraints on Metabolism
PI Name: Bernhard Palsson
Institution Name: University of California-San Diego

The international workshop entitled "[Realistic Theories of Correlated Electron Materials](#)" brought together researchers to discuss combining theoretical and computational advances to work toward a quantitative and predictive approach to strongly correlated electron materials. These materials are of significant interest, both scientifically and in several cases technologically. ([0096462](#) - Strongly Correlated Fermi Systems; [9907949](#) - Institute for Theoretical Physics). This project created a data set of geographic information useful to a broad group of researchers but that would have been prohibitively expensive and time consuming for single projects to develop. This project coordinated the creation and release of three suites of spatial data products. ([0224071](#) -

High-Resolution Imagery and Terrain Model for Collaborative Research of Environmental Change at Barrow, Alaska.)

[0096462](#)

Funded under: IDEAS
Award Title: Strongly Correlated Fermi Systems
PI Name: Gabriel Kotliar
Institution Name: Rutgers University New Brunswick

[9907949](#)

Funded under: TOOLS
Award Title: Institute for Theoretical Physics
PI Name: David Gross
Institution Name: University of California-Santa Barbara

[0224071](#)

Funded under: IDEAS
Award Title: High-Resolution Imagery and Terrain Model for Collaborative Research of Environmental Change at Barrow, Alaska
PI Name: William Manley
Institution Name: University of Colorado at Boulder

This workshop promoted discussions about comparative developmental physiology, an emerging scientific area that links comparative animal physiology and evolutionary developmental biology. The meeting and the resulting listserve, a web site, and book have fostered this emerging scientific area. ([9979751](#) - Travel Support for 5th International Congress of Comparative Physiology and Biochemistry to be held in Calgary, Alberta, Canada from August 23-28, 1999.)

[9979751](#)

Funded under: PEOPLE
Award Title: CONFERENCE: Travel Support for 5th International Congress of Comparative Physiology and Biochemistry to be held in Calgary, Alberta, Canada from August 23-28, 1999.
PI Name: Warren Burggren
Institution Name: University of North Texas

Methods for tuning highly configurable system-on-a-chip designs, including memory reconfiguration and hardware/software partitioning, to specific embedded applications were developed under NSF funding. The main research outputs of the project were the techniques embodied in a prototype system-on-a-chip exploration tool called Platune. ([9876006](#) - IP-Based Embedded Systems Design)

[9876006](#)

Funded under: PEOPLE
Award Title: CAREER: IP-Based Embedded Systems Design
PI Name: Frank Vahid
Institution Name: University of California-Riverside

Researchers at MIT's Center for Bits and Atoms (NSF CCR-0122419) have introduced a new approach to protecting information, by developing a physical way to implement a key cryptographic primitive. The MIT team showed that light scattering in the "mesoscopic" limit of multiple scattering is equivalent to a one-way function, allowing this mathematical function to be performed by a penny's worth of materials. ([0122419](#) - Center for Bits and Atoms).

[0122419](#)

Funded under: IDEAS
Award Title: ITR/SY: Center for Bits and Atoms
PI Name: Neil Gershenfeld
Institution Name: Massachusetts Institute of Technology

This research has developed the Probabilistic Roadmap Planner (PRM) which has significantly advanced our capabilities in planning paths for one or more than one robot moving in a cluttered environment and has had a broad impact in the robotics community. It has caused a paradigm shift and introduced randomization as an effective means of exploring huge spaces. PRM provides a new paradigm for searching which has found applications beyond the robotics community and industry. ([9702288](#) - Robot Algorithms for the Physical World)

[9702288](#)

Funded under: IDEAS
Award Title: CAREER: Robot Algorithms for the Physical World
PI Name: Lydia Kavraki
Institution Name: William Marsh Rice University

Prospective analysis:

The prospective portfolio shows good potential for advancing many emerging fields. Examples include tissue engineering, cognitive science, biological physics and information management including advances in geospatial methodology. Examples of promising projects follow:

The Center for Theoretical Biological Physics represents the emerging field of biological physics and involves a cross-fertilization of ideas and methods from biology and biochemistry on the one hand and the physics of complex systems on the other. This multi-partner effort has the potential for playing an important role in defining this new field of science. ([0216576](#) - Center for Theoretical Biological Physics)

[0216576](#)

Funded under: IDEAS
Award Title: Center for Theoretical Biological Physics
PI Name: Jose Onuchic
Institution Name: University of California-San Diego

This interdisciplinary project reflects potential advances in the science of information management, focusing in particular on geospatial information. It addresses the development of concepts, algorithms, and system architectures to enable users on a grid to query, analyze, and contribute to multivariate, quality-aware geospatial information with potential applications in mobile computing, bioinformatics, and geographic information systems. ([0121269](#) - ITR/IM: Enabling the Creation and Use of 9GeoGrids for Next Generation Geospatial Information)

[0121269](#)

Funded under: IDEAS
Award Title: ITR/IM: Enabling the Creation and Use of GeoGrids for Next Generation Geospatial Information
PI Name: Peggy Agouris
Institution Name: University of Maine

TOOLS OUTCOME GOAL: DETAILED ASSESSMENT OF PERFORMANCE

NSF OUTCOME GOAL FOR TOOLS: PROVIDING “BROADLY ACCESSIBLE, STATE-OF-THE-ART AND SHARED RESEARCH AND EDUCATION TOOLS.”

NSF’s performance for the TOOLS Strategic Outcome is successful when, in the aggregate, results reported in the period demonstrate significant achievement in the majority of the following indicators:

T1: Development or provision of tools⁹ that enables discoveries or enhances productivity of NSF research or education communities.

Retrospective analysis:

- *Has NSF demonstrated significant achievement for this indicator as a result of the outcomes of past awards? YES*

The seven project summaries chosen for illustrative purposes from a group of more than one hundred projects show significant achievement in the several facets of this indicator: The High Performance Nuclear Magnetic Resonance Probes developed at the National High Magnetic Field Laboratory, the Arcminute Cosmology Bolometer Array Receiver and the Telemicroscopy Portal hosted by the National Partnership for Advanced Computational Infrastructure are enabling questions to be posed and discoveries to be made at the very frontiers of knowledge. The Telemicroscopy Portal, National Nanofabrication Users Network, Data Mining of the National Virtual Observatory and the project in Internet Satellite Connection to Under-served Sites support significant achievements in both discovery enabling and leading-edge instruments and databases

⁹ For example, includes research and education infrastructure such as large centralized facilities, or integrated systems of leading-edge instruments, or databases, or widely utilized, innovative computational models or algorithms, or information that provides the basis for a shared-use networked facility.

through networked facilities. The project on Speech Assisted Learning for Braille students is a significant TOOL development in education infrastructure that enables and enhances the participation of the visually impaired in the nation's science and technology enterprise.

Data Mining the National Virtual Observatory is a comprehensive effort that enhances the productivity of established investigators and enables discoveries by new investigators through the provision of advanced computational infrastructures and 18 terabytes of astronomical data and images.

[9619020](#)

Funded under: TOOLS
Award Title: National Partnership for Advanced Computational Infrastructure
PI Name: Francine Berman
Institution Name: University of California-San Diego

High-Performance Probes Developed at NHMFL enables new discoveries through the development of non-commercially available NMR probes for applications in high magnetic fields utilizing the unique design, fabrication and testing capabilities of the National High Magnetic Field Laboratory, which is a centralized, widely utilized facility.

[0084173](#)

Funded under: TOOLS
Award Title: National High Magnetic Field Laboratory
PI Name: Jack Crow
Institution Name: Florida State University

Most Detailed Images of the Early Universe were provided using the newly developed NSF funded Arc-minute Cosmology Bolometer Array Receiver that was integrated into other NSF-supported major facilities in Antarctica. This new and unprecedented information on the early Universe benefited from other NSF-funded work in international locations.

[0091840](#)

Funded under: IDEAS
Award Title: Arcminute Cosmology Bolometric Array Receiver
PI Name: William Holzapfel
Institution Name: University of California-Berkeley

National Nanofabrication Users Network (NNUN) supports a comprehensive program of databases, shared-use networked facilities and educational activities that enable discovery and enhance productivity for Nanofabrication community. The impact of this effort is significant in the research, education and business communities.

[9731293](#)

Funded under: TOOLS
Award Title: Renewal Proposal for the National Nanofabrication Users Network
PI Name: Sandip Tiwari
Institution Name: Cornell University – Endowed

Speech Assisted Learning (SAL) for Braille Students has led to the World's first stand-alone Braille learning system with very promising prospects for commercialization and widespread distribution. This system of hardware and software provides the complete means for teaching Braille mathematics, science and computer codes. Thus, enabling the visually impaired to participate in the discovery process in science and technology.

[9760018](#)

Funded under: PEOPLE
Award Title: SBIR Phase I: Speech Assisted Braille Math
PI Name: Sally Mangold
Institution Name: Exceptional Teaching Aids

[9901450](#)

Funded under: PEOPLE
Award Title: SBIR Phase II: Speech Assisted Braille Math
PI Name: Sally Mangold
Institution Name: Exceptional Teaching Aids

Telemicroscopy enables an extensive NSF-funded infrastructure in advanced computing to be merged with leading-edge microscopy facilities in the U.S. and other nations to give a unique opportunity, e.g. the Telescience Portal, for remote operation of microscopes.

[9619020](#)

Funded under: TOOLS
Award Title: National Partnership for Advanced Computational Infrastructure
PI Name: Francine Berman
Institution Name: University of California-San Diego

Internet Satellite Connection to Under-served Sites provides discovery-enabling and productivity-enhancing tools to researchers, educators and students at sites under-served with respect to Internet connectivity by means of an Internet Satellite connection. The seventy geographically remote institutions enjoy Internet connectivity that makes them more attractive to leading researchers and aspiring students.

[0073240](#)

Funded under: TOOLS
Award Title: Advanced Internet Satellite Extension Project
PI Name: Janet Poley
Institution Name: ADEC/AgSAT

Prospective analysis:

From a set of more than 30 projects, the three examples chosen speak strongly to the prospects for significant impact and achievements in the future. First, each of them is a high-risk effort, which, if successful, will open up new and unforeseen opportunities for scientific discoveries and advancements. Two of them, The EarthScope program in Understanding the Evolution of the Earth's Crust and the NCAR effort in Ultrafine

Aerosols push the limits of instrument and measurement technology. Remote Sensing of the Ionosphere Using New Passive Radar holds the promise of uncovering relationships in an existing technology and has great potential for generating widely utilized databases. The EarthScope effort in understanding the evolution of the Earth's crust shows significant planning and a highly articulated infrastructure initiative in education and research.

EarthScope: A Collaborative Facility for Imaging and Understanding the Evolution of the Earth's Crust supports a scientific infrastructure initiative, Earthscope, for integrated observational facilities dealing with the evolution of continents and processes related to earthquakes and volcanoes. The exciting aspect of this project is its exploitation of new sensor technology in and integrated network for which the resulting data is available in real-time to a widely distributed community of researchers, educators and students. Significant partnering of the research community with federal and state agencies took place in developing this initiative.

[0208457](#)

Funded under: TOOLS
Award Title: Earthscope: A New View of Earth and Earth Science
PI Name: Michelle Hall-Wallace
Institution Name: University of Arizona

Ionospheric Remote Sensing Using New Passive Radar Technology uses extant technology, FM radio, in a unique and highly innovative fashion to enable discoveries concerning solar wind and plasma interactions with the earth's magnetic field in the ionosphere. There is considerable potential for further applications of this tool.

[9816217](#)

Funded under: TOOLS
Award Title: Radar and Fluid Theory Investigation of E Region Irregularities
PI Name: John Sahr
Institution Name: University of Washington

New NCAR instrument reveals ultrafine aerosols and permits the understanding of their profound influence on human health and the atmosphere. Studying ultrafine aerosols and understanding the mechanisms for their action has been hampered by the lack of suitable instruments.

[9732665](#)

Funded under: TOOLS
Award Title: Operation of the National Center for Atmospheric Research and Support of Other Scientific Activities
PI Name: Richard Anthes
Institution Name: University Corporation For Atmospheric Res

T2: Partnerships with local, state or federal agencies, national laboratories, industry or other nations to support and enable development of large facilities or other infrastructure.

Retrospective analysis:

- *Has NSF demonstrated significant achievement for this indicator as a result of the outcomes of past awards? YES*

Partnerships with other research and funding agencies, both national and international, have become a successful and integral part of the resources and tools available to support NSF research. Through these partnerships, the reach of NSF research extends far beyond what can be accomplished through the investment of NSF resources alone. Observational, analytical and computational resources are expanded and disciplinary diversity is enhanced. In addition to expanding the infrastructure base, partnerships in the development and operation of large facilities can stimulate interactions in cross-disciplinary research and the application of new technologies in sensor design, data storage and communication.

NSF is a world leader in research and in international collaboration. In some cases, international partnerships are driven by fiscal reality (e.g. experimental facilities for high-energy physics, radio astronomy, deep sea drilling) – the projects would simply not be feasible without significant investment and cost-sharing from international partners. In other cases (e.g. oceanographic facilities, global atmospheric and geophysical networks) the global breadth of the observation systems requires multinational participation. In others, unique geographic requirements demand that the facilities be established outside the U.S., usually in partnership with the host country (e.g. high altitude telescopes, Antarctic support services).

University researchers often gain access to special purpose tools and observational systems, and participate in the development of new systems, through NSF leadership in partnership with other U.S. federal research and mission agencies. For example, experiments in high energy physics depends heavily on shared use of facilities at Department of Energy (DOE) supported national labs. Research throughout the geosciences is carried out using facilities developed and shared with National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, United States Geological Survey, DOE and Department of Defense. . NSF leadership and coordination have been especially important in the myriad of partnerships (national and international; government and private) that impact research in the area of computer science and information technology.

[Constellation Observing System for Meteorology Ionosphere and Climate](#)

Summary - In addition to its geophysical application in monitoring small movements of the Earth's crust, the Global Positioning System (GPS) can also be used in studies and

prediction of weather, climate and space weather. As a result of the successful proof-of-concept project, NSF, through an award to the University Corporation for Atmospheric Research, is now leading a consortium of five federal agencies, in partnership with Taiwan, to launch a fleet of special GPS satellites to make active soundings of Earth's atmosphere. The project will culminate in a joint U.S.-Taiwan COSMIC (Constellation Observing System for Meteorology, Ionosphere, and Climate) mission that will be launched in late 2005 and is expected to collect approximately 3,000 soundings per day.

This project involves international collaboration (U.S.-Taiwan, plus five U.S. agencies) and shows cross-over use of a single observational system (GPS) for applications in both solid Earth and atmospheric research

[9908671](#)

Funded under: TOOLS
Award Title: Constellation Observing System for Meteorology Ionosphere and Climate
PI Name: Richard Anthes
Institution Name: University Corporation For Atmospheric Res

[Gemini transforms a desert](#)

Summary - Looking well outside our galactic neighborhood, an international team has equipped the Gemini telescopes in Hawaii and Chile with a unique and powerful technique that counteracts the fluorescence that contaminates the far-red end of the optical spectrum in the night sky. Gemini's scientific mission is focused on fundamental questions, using new technologies and new observational and operational approaches. This award supports a collaboration consisting of the United States, the United Kingdom, Canada, Australia, Chile, Argentina, and Brazil.

The Gemini telescopes are an example of a complex, expensive and geographically distributed system (Hawaii and Chile) that is operated through an international partnership (United States, the United Kingdom, Canada, Australia, Chile, Argentina, and Brazil).

[0084699](#)

Funded under: TOOLS
Award Title: Gemini 8 Meter Telescope
PI Name: William Smith
Institution Name: AURA/National Optical Astronomy Observatories

[NSF - DOE Collaboration to Study Deep-Sea Gas Hydrates](#)

Summary - Marine deposits of gas hydrates represent an enormous reservoir of sequestered carbon of interest both as a potential energy source and as an agent of past climate change. Joint funding from NSF and the DOE made it possible to collect and preserve samples of gas hydrate at in situ conditions during Leg 204 of the Ocean Drilling Program off the coast of Oregon.

The Ocean Drilling Program (ODP) is a large international partnership in which NSF plays a major role in terms of facility support and scientific direction. This project, carried out during a single ODP cruise, shows an additional level of partnership through an experiment jointly funded by NSF and DOE.

[9308410](#)

Funded under: TOOLS
Award Title: Management and Operations of the Ocean Drilling Program
PI Name: Daniel Weill
Institution Name: Joint Oceanographic Institutions Inc

[Solving the puzzle of the Forma Urbis Romae](#)

Summary - This project supported as part of the Information Technology Research (ITR) program will use computer shape matching algorithms to assemble the remaining fragments of the Forma Urbis Romae, a giant marble map of ancient Rome that dates to the second century AD. The map now consists of 1,163 fragments, and is incomplete. Piecing the remaining fragments together is a unique challenge for computer graphics research. The project, a collaboration between researchers from Stanford and Rome, will produce and disseminate a database of 3D models and photographs of this famous archaeological document and in the process, contribute new algorithms for shape matching.

This is an example of how NSF infrastructure, through ITR-supported facilities for data collection and image analysis, is used in a collaborative, international project.

[0113427](#)

Funded under: TOOLS
Award Title: ITR: Solving the Puzzle of the Forma Urbis Romae
PI Name: Marc Levoy
Institution Name: Stanford University

[0219856](#)

Funded under: TOOLS
Award Title: ITR: High Performance Imaging Using an Array of Low-Cost Cameras
PI Name: Marc Levoy
Institution Name: Stanford University

[Telemicroscopy](#)

Summary - As part of the National Partnership for Advanced Computational Infrastructure (NPACI), the Telescience Portal for Neuroscience links highly specialized microscope instruments for use by researchers in the Netherlands, Japan, Taiwan, and the United States over a dedicated, state-of-the-art network. It is now in wide multidisciplinary use by structural neurobiologists, molecular and cell biologists, electron microscopists, and computer scientists within and beyond NPACI. The same technology has been used in a National Institutes of Health (NIH)-funded nationwide effort called the Biomedical Informatics Research Network (BIRN).

This project adopts a web-based approach for utilization of very expensive scientific instrumentation. It contributes to the development and provision of tools that enable discoveries or enhance productivity of NSF research communities in an international, inter-agency environment.

[9619020](#)

Funded under: TOOLS
Award Title: National Partnership for Advanced Computational Infrastructure
PI Name: Francine Berman
Institution Name: University of California-San Diego

[U.S. & Europe Sign Agreement for the World's Most Powerful Radio Telescope](#)

Summary - The Atacama Large Millimeter Array (ALMA) in Chile is an international facility involving organizations in the U.S., Chile, Canada, Japan and Europe. The antenna array will provide unprecedented resolution and sensitivity at very high radio frequencies, and will help probe planet and star formation, the formation of early galaxies and galaxy clusters, and the detection of organic molecules in space, among other topics. ALMA will expand the frontiers of radio astronomy by facilitating the highest resolution imagery at the highest sensitivity of any existing radio telescope.

This international collaboration will involve researchers, technicians, and project management personnel of diverse nationalities. The development, construction, and use of ALMA will be a truly global project involving support and use by organizations in the US, Chile, Canada, Japan and Europe.

[0244577](#)

Funded under: TOOLS
Award Title: Atacama Large Millimeter Array (ALMA)
PI Name: Riccardo Giacconi
Institution Name: Associated Universities Inc/National Radio Astronomy Observatory

Prospective analysis:

Many of the large facilities supported by NSF are inherently long-term and evolutionary. New facilities, especially those proposed for support through the MREFC account (EarthScope, NEON, Scientific Ocean Drilling, Rare Symmetry Violating Processes (RSVP), Ocean Observatories), will provide the infrastructure to expand the horizons for future disciplinary research. All of these MREFC projects are built on strong partnerships at the national level between universities and government agencies and all involve various levels of international collaboration as well. NSF involvement in the new information technology initiatives, such as Cyberinfrastructure as described in the Atkins report, will see impact, throughout the NSF portfolio, in areas such as sensor and communication grids, shared data repositories, interdisciplinary collaboration, and enhanced visualization. At the same time, many of the existing facilities require ongoing support, both to enable future programs that require long-term observations and to provide for upgrade to take advantage of improved observational techniques (e.g. ALMA-II).

[Dental Identification System](#)

Summary - This grant will support the development of tools for rapid identification of individuals based on dental records. The technology proposed has potential for high impact in investigations, such as the World Trade Center, where only dental records are available to aid in victim identification. The results will contribute to the mission of a Federal Agency (the FBI) in identifying deceased individuals.

[0131079](#)

Funded under: IDEAS
Award Title: Digital Government: Automated Dental Identification
PI Name: Hany Ammar
Institution Name: West Virginia University Research Corporation

[Drill System Development for ANDRILL \(Antarctic Drilling\)](#)

Summary - The Office of Polar Programs has recently invested in the development of a new geological drilling system that will be capable of recovering continuous sediment core from beneath Antarctic ice shelves and land-fast sea ice. Such sediment cores constitute valuable records of conditions of the continental margin marine environment as well as records of conditions on nearby areas of the continent. The ANDRILL drill system development is a collaborative effort among scientists in the United States, Germany, and New Zealand.

This project involves U.S., German and New Zealand participation in specific hardware development, within the context of the large multidisciplinary, multi-national research activities in Antarctica.

[0216522](#)

Funded under: TOOLS
Award Title: Collaborative Research: Acquisition of a drilling rig to recover geological records from the Antarctic margin for the ANDRILL Consortium
PI Name: David Harwood
Institution Name: University of Nebraska-Lincoln

[0216513](#)

Funded under: TOOLS
Award Title: Collaborative Research: Acquisition of a Drilling Rig To Recover Geological Records from the Antarctic Margin for the ANDRILL Consortium
PI Name: Ross Powell
Institution Name: Northern Illinois University

[GEON - Building an Information Network for the Geosciences](#)

Summary - The GEOsciences Network (GEON) project is a collaboration between Information Technology Research (ITR) and Geoscience researchers with the goal of creating a modern information technology framework for the Earth sciences. A major

partner in GEON is the U.S. Geological Survey (USGS), which will collaborate in building broader access through GEON to selected USGS national scale geological databases. The research products and services arising from GEON will be available to the entire scientific community and will transform the way in which geoscience research is conducted, opening unprecedented avenues for research and collaboration and providing the foundation for creating geoscience collaboratories.

GEON is an example of the disciplinary use of ITR infrastructure to support national partnerships between university and government agencies in developing shared databases for Earth Science research.

[0225673](#)

Funded under: TOOLS
Award Title: ITR Collaborative Research: GEON: A Research Project to Create Cyberinfrastructure for the Geosciences
PI Name: Chaitanya Baru
Institution Name: University of California-San Diego

T3: Development or implementation of other notable approaches or new paradigms¹⁰ that promote progress toward the TOOLS outcome goal.

Retrospective analysis:

- *Has NSF demonstrated significant achievement for this indicator as a result of the outcomes of past awards? YES*

NSF has funded a diverse group of projects that illustrates notable approaches or new paradigms that promote progress toward the TOOLS outcome goals. Significant achievement is demonstrated in the area of software development that could lead to the generation of large databases for the analyses of genes, proteins, RNAs, small molecules, microorganisms and human resources for science and engineering. These databases will be central for the success of future NSF funded projects.

[ITR/IM+AP: Automated compilation and computational analysis of regulatory networks](#) concerned the development of search engine software, GeneWays, which allows for the fully automated extractions from journal articles information on the relationships between substances (genes, proteins, RNAs, small molecules, etc) or processes using a natural-language processing technology. The system can search thousands of articles and put the related information in a database for future review. This nugget was selected because it describes the development of technology that may substantially reduce the manual work in searching the literature and databases for new discoveries and existing relations

¹⁰ For example, broad-based, program-wide results that demonstrate success related to management/utilization or large data sets/information bases, or development of information and policy analyses, or use of the Internet to make STEM information available to NSF research or education communities, or exceptional examples of broadly accessible tools shared by NSF research and education communities.

between substances. The system could have a significantly broad impact on academic research and industrial R&D.

[0121687](#)

Funded under: TOOLS
Award Title: ITR/IM+AP: Automated Compilation and Computational Analysis of Regulatory Networks
PI Name: Andrey Rzhetsky
Institution Name: Columbia University

[Mining the Bibliome](#): Information Extraction from the Biomedical Literature illustrates research that will result in the broad use of developed software to automatically extract information from the biomedical literature by relying on three techniques: high-accuracy parsing, shallow semantic analysis and integration of existing data bases.

[0205448](#)

Funded under: IDEAS
Award Title: ITR: Mining the Bibliome -- Information Extraction from the Biomedical Literature
PI Name: Aravind Joshi
Institution Name: University of Pennsylvania

[Analysis of Microbial Communities](#): Using a DNA Array Approach illustrates a project that should result in the development of broadly used tools to be shared by NSF research and education communities involving the development of DNA Array technology in an approach termed "Oligonucleotide fingerprinting of RNA genes (OFRG)." Although the PIs developed the OFRG approach for bacteria and fungi their intended development of high throughput systems that will allow for the examination of thousands of rDNA clones simultaneously instead of the 1500 rDNA clones capable of being analyzed by the current protocols would make the technology accessible to the entire life sciences research community.

[0133265](#)

Funded under: TOOLS
Award Title: Analysis of Microbial Communities Using a DNA Array Approach
PI Name: James Borneman
Institution Name: University of California-Riverside

[Collaborative Research for a National eWorkshops: Interactive On-line Workshops](#), an ITR project, is an outstanding example of research, which could result in a drastic change in the way workshops are conducted. The technology developed in this project would facilitate workshops to be conducted online and thus significantly reduce the costs.

[0086078](#)

Funded under: IDEAS
Award Title: ITR: Collaborative Research for a National Center for Empirical Software Engineering Research
PI Name: Victor Basili
Institution Name: University of Maryland College Park

[0085788](#)

Funded under: IDEAS
Award Title: ITR: Collaborative Research Proposal for a National Center for Empirical Software Engineering Research
PI Name: Scott Henninger
Institution Name: University of Nebraska-Lincoln

[0085749](#)

Funded under: IDEAS
Award Title: ITR: Collaborative Research Proposal for a National Center for Empirical Software Engineering Research
PI Name: Rayford Vaughn
Institution Name: Mississippi State University

[Computational Tools for K-12 Science Education](#) demonstrates success related to the development of broadly accessible tools that can be used by a variety of NSF research and education communities. The project has resulted in the development of biosensors that can be directly interfaced with computers. A large number of biosensors can then be constructed for rapid screening of many biological agents and new therapeutic drug candidates.

[0085946](#)

Funded under: TOOLS
Award Title: ITR: Learning-Centered Design Methodology: Meeting the Nation's Need for Computational Tools for K-12 Science Education (Engineering Scaffolded Work Environments)
PI Name: Elliot Soloway
Institution Name: University of Michigan Ann Arbor

Prospective analysis:

NSF continues to fulfill the TOOLS outcome goal of funding projects and programs that have the potential of developing large data sets/information bases or for the development of information and policy analyses or use of the Internet to widely distribute STEM information.

[A New Program: Human Language and Communication](#) illustrates the development of an advanced computer program for processing text, speech, and multi-modal communications. The methodologies of this project may involve one or more languages and may include supervised and unsupervised machine learning, corpus-based approaches, statistical techniques, symbolic techniques, and other approaches.

Results of this research could lead to important applications in speech/language technology that would allow for the management of vast amounts of text, speech, and video interactions that are available on the Internet.

[0200983](#)

Funded under: PEOPLE
Award Title: Synthesis and Acquisition of Communicative Gestures
PI Name: Norman Badler
Institution Name: University of Pennsylvania

[0208028](#)

Funded under: IDEAS
Award Title: Reducing the Corpus Annotation Bottleneck for Natural Language Learning
PI Name: Claire Cardie
Institution Name: Cornell University - Endowed

[0208985](#)

Funded under: TOOLS
Award Title: Collaborative: Improving Subjectivity Analysis to Achieve High-Precision Information Extraction
PI Name: Ellen Riloff
Institution Name: University of Utah

[Dental Identification System](#) is an example of a moderately high-risk project aimed at development of an automated state-of-the-art dental digital image identification system. This project serves as an example of a partnership between NSF and the FBI. The techniques of image processing will be applicable for use by many other domains.

[0131079](#)

Funded under: IDEAS
Award Title: Digital Government: Automated Dental Identification
PI Name: Hany Ammar
Institution Name: West Virginia University Research Corporation

[Information on Graduates and Faculty of Community Colleges](#) is an example of research conducted by NSF's SRS Division. The SRS is expanding its efforts to study the role of science and engineering (S&E) graduates and faculty at community colleges. This report should be notable in that it will provide insight into the role community colleges play in developing human resources in science and technology.

[0120238](#)

Funded under: TOOLS
Award Title: Support Services for the Scientists and Engineers Statistical Database (SESTAT)
PI Name: Patrick Joy
Institution Name: National Institutes of Health Public Health Service

[Theory-Based Evaluation to Support STEM Programs](#) is an example of a project aimed at evaluating NSF STEM programs. The results are expected to have impacts leading to improvements in evaluation design, NSF program design and NSF program review.

[0230435](#)

Funded under: TOOLS
Award Title: Building Evaluation Capacity with Theory-Based Evaluation
PI Name: Mary Ann Millsap
Institution Name: ABT Associates Inc