College of Charleston
66 George Street
Charleston, South Carolina 29424-0001

July 30, 2004

Dr. Arden L. Bement, Jr.
Acting Director
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Bement:

We are pleased to submit the report of the Advisory Committee for GPRA Performance Assessment (AC/GPA) for 2004. It was the unanimous judgment of the Committee that NSF has demonstrated significant achievement for all indicators in all the three strategic outcome goals of People, Ideas, and Tools and for the merit review indicator for the Organizational Excellence outcome goal. The Advisory Committee for Business and Operations concluded that NSF demonstrated significant achievement for the other indicators in the Organizational Excellence goal.

The Committee also concluded that the four outcome goals are mutually reinforcing and synergistic. They represent an integrated framework that combines research and education in a positive way and also provides the organizational infrastructure to advance the national scientific, technological, engineering, and mathematics enterprise. Thus, all four goals should always be considered as an integrated whole when assessing NSF's performance.

The Committee was enormously impressed and pleased with the improvements made in the AC/GPA process this year. These changes facilitated the completion of much of the indicator analysis in advance and this enabled more substantive and meaningful discussions at the meeting.

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 demonstrated that advisory committees can themselves demonstrate organizational excellence and become "learning committees." NSF is indeed fortunate to have such people in its "corner" and 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 Performance and 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 (AC/GPA)

Submitted: July 30, 2004
Norine E. Noonan, Ph.D.
Chairman

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

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Vice President for Instruction
Prince George's Community College
Largo, MD

June 2004

NSF Strategic Plan, FY 2003 – 2008
Strategic Outcome Goals

PEOPLE GOAL

A DIVERSE, COMPETITIVE, AND GLOBALLY-ENGAGED U.S. WORKFORCE OF SCIENTISTS, ENGINEERS, TECHNOLOGISTS AND WELL-PREPARED CITIZENS

Goal Indicators

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

P2: Support programs that attract and prepare U.S. students to be highly qualified members of the global S&E workforce, including providing opportunities for international study, collaborations and partnerships.

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

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

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

IDEAS GOAL

DISCOVERY ACROSS THE FRONTIER OF SCIENCE AND ENGINEERING, CONNECTED TO LEARNING, INNOVATION, AND SERVICE TO SOCIETY

Goal Indicators

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

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

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

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

I5: Provide leadership in identifying and developing new research and education opportunities within and across S&E fields.

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

TOOLS GOAL

BROADLY ACCESSIBLE, STATE-OF-THE-ART S&E FACILITIES, TOOLS AND OTHER INFRASTRUCTURE THAT ENABLE DISCOVERY, LEARNING AND INNOVATION

Goal Indicators

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

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

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

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

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

ORGANIZATIONAL EXCELLENCE GOAL

AN AGILE, INNOVATIVE ORGANIZATION THAT FULFILLS ITS MISSION THROUGH LEADERSHIP IN STATE-OF-THE-ART BUSINESS PRACTICES

Excellence in managing NSF's activities is an objective on par with the Foundation's mission-oriented outcome goals. It is critical to achievement of all NSF goals. In addition, this goal addresses the President's Management Agenda and focuses on management challenges and reforms identified by OMB or the General Accounting Office, in NSF's annual review of financial and administrative systems as required by the Federal Managers' Financial Integrity Act, or by the NSF Office of Inspector General.

Investment Categories: *The following long-term investment categories directly link to NSF programs and budget resources.*

- **Human Capital:** Investments that produce a diverse, agile, results-oriented cadre of NSF knowledge workers committed to enabling the agency's mission and to constantly expanding their abilities to shape the agency's future.

- **Business Processes**: Investments that produce effective, efficient, strategically aligned business processes that integrate and capitalize on the agency's human capital and technology resources.

- **Technologies and Tools**: Investments that produce flexible, reliable, state-of-the-art business tools and technologies designed to support the agency's mission, business processes, and customers.

Objectives: Excellence in managing the agency's activities underpins all of NSF's goals. The following objectives are especially critical to NSF's goal achievement.

- **Operate a credible, efficient merit review system.** NSF's merit review process is the keystone for award selection, through which NSF achieves its goals. All proposals for research and education projects are evaluated using two criteria: the intellectual merit of the proposed activity and its broader impacts. Specifically addressed in these criteria are the creativity and originality of the idea, the development of human resources, and the potential impact on the research and education infrastructure. Ensuring a credible, efficient system requires constant attention and openness to change.

- **Utilize and sustain broad access to new and emerging technologies for business application.** NSF has moved aggressively to adopt new technologies in our business processes. NSF must sustain and further develop exemplary mechanisms to streamline business interactions, enhance organizational productivity, ensure accessibility to a broadened group of participants, and maintain financial integrity and internal controls.

- **Develop a diverse, capable, motivated staff that operates with efficiency and integrity.** NSF is dependent on the capability and integrity of its staff. Innovative methods of recruitment, development, retention and employee recognition are needed to meet future challenges.

- **Develop and use performance assessment tools and measures to provide an environment of continuous improvement in NSF's intellectual investments as well as its management effectiveness.** An organization that is dependent on public funds must be accountable to the public. The development and use of effective indicators of agency performance -- measuring NSF's ability to meet mission-oriented goals, its competent use of resources in the investment process, and its efficiency and effectiveness as a reliable partner to others -- are needed to better explain the agency's role to the public.

OVERALL SUMMARY AND CONCLUSIONS

The Advisory Committee for GPRA Performance Assessment (AC/GPA) met on June 22-23, 2004 at the National Science Foundation (NSF) in Arlington, VA to consider the activities and achievements of NSF relative to its Government Performance and Results Act (GPRA) performance goals for FY 2004. The charge to the Committee asked that it provide:

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

The Committee reviewed voluminous materials from NSF's award portfolio both prior to and during the meeting. In addition, the Committee had electronic access to supporting documentation for all indicators including a large database of accomplishments (which NSF terms "nuggets"), annual and final project reports and an extensive set of reports from various Committees of Visitors (COVs). The Committee also received input on the Organizational Excellence (OE) goal from the Advisory Committee for Business and Operations (AC/B&O). The AC/GPA reviewed materials supporting an assessment of the merit review indicator of the OE goal. The group conducted extensive discussions on the indicators for NSF's four strategic outcome goals. ***It was the unanimous judgment of the Committee that NSF has demonstrated significant achievement for all indicators in the People, Ideas, and Tools goals and also for the merit review indicator of the Organizational Excellence outcome goal. The Advisory Committee on Business and Operations concluded that NSF demonstrated significant achievement for the other indicators of the Organizational Excellence goal.***

The Committee also concluded that the four outcome goals are mutually reinforcing and synergistic. They represent an integrated framework that combines research and education in a positive way and also provides the organizational infrastructure to advance the national scientific, technological, engineering, and mathematics enterprise. The extensive documentation also underscores the interdependence of NSF's 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, the education and training of a national workforce highly qualified in science, engineering and mathematics, continuous innovation in business processes that are both fair and efficient, and periodic, independent assessment of quality and relevance. Thus, the four goals should always be considered as an integrated whole when assessing NSF's overall performance.

NSF's 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. NSF's accomplishments in the ORGANIZATIONAL EXCELLENCE goal demonstrate innovation in business processes; in methods of recruitment, development, retention, and recognition of its staff; attention to continuous improvement in management effectiveness; and a strong commitment to continued improvements in its merit review process. Taken together, the strategic outcome goals demonstrate excellence, relevance and leadership. The nation's investment in these activities is well made.

This report is organized as follows:

- A Foundation level summary of FY 2004 investments, including comment on the R&D investment criteria of quality and relevance, and comments on NSF's portfolio of innovative, high risk, and multidisciplinary awards
- Information on the approach and methodologies used by the Committee
- Detailed assessment of the People outcome goal
- Detailed assessment of the Ideas outcome goal
- Detailed assessment of the Tools outcome goal
- Detailed assessment of the Merit Review Indicator of the Organizational Excellence outcome goal with a meta-assessment of the other three OE indicators
- Comments on the AC/GPA process and the Committee's work
- Appendix I: List of accomplishments (nuggets) cited in the report
- Appendix II: Letter from Advisory Committee for Business and Operations, with NSF Self-Assessment of OE outcome goal

The Committee would like to extend its deep gratitude to the NSF GPRA staff, particularly Patricia Tsuchitani, Craig Robinson, Eve Barak, Betty Wong, Blane Dahl, Jennie Moehlmann, Morris Aizenman, and Kelli Savia (student intern) 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 pressure. We want to especially thank Peggy Gartner and Theresa Rinehart for developing, refining, and improving the outstanding database for accomplishments. We would also like to thank Joan Miller for her cheerful and competent administrative support before and during the meeting. Lastly, we thank the NSF program officers for their thoughtful reporting of accomplishments of their program portfolios, and NSF's senior leadership for their commitment to this effort.

APPROACH AND METHODOLOGIES USED BY THE AC/GPA

The Advisory Committee for GPRA Performance Assessment (AC/GPA) is comprised of 21 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 experience. 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. The findings and recommendations of the Committee will provide valuable input to NSF's annual Performance and Accountability Report.

The focus of the AC/GPA is on the activities and results associated with the indicators and emphasis areas of NSF's four strategic outcome goals: PEOPLE, IDEAS, TOOLS, and ORGANIZATIONAL EXCELLENCE (OE). The principal work of the Committee was conducted as a "committee of the whole." Three subgroups (PEOPLE, IDEAS, and TOOLS) composed of AC/GPA members provided the detailed analysis of the results associated with each indicator. A fourth subgroup for OE was comprised of the AC/GPA Chairman, Vice Chairman, and one other committee member. All of the subgroups reported their analyses, findings, and conclusions to the full AC/GPA for its discussion. Within the subgroups, each AC/GPA member was assigned specific indicators to review on the basis of a large volume of accomplishments 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 response to a suggestion by the Committee last year, NSF endeavored to assure that the largest 30 programs were represented in the database.

Materials were available to Committee members via a secure website where information was accessible and much of it was electronically linked to the source documentation three months before the annual meeting. Thus, the Committee members were able to do virtually all of the indicator analysis well ahead of the meeting. This is a marked improvement over previous years and provided a welcome opportunity to enrich and enlarge the discussion at the meeting (rather than struggling with selection of nuggets). The subgroups (and the full Committee) had a large amount of material available for its work, including:

- A large database of accomplishments (aka "nuggets")
- Committee of Visitors reports (limited to those that had been received, presented to, and accepted by the relevant directorate advisory committee)
- A database containing the universe of annual and final project reports
- NSF's Strategic Plan
- NSF's Budget Requests to Congress
- Relevant National Science Board reports
- Information from NSF's management information systems was provided when necessary for committee deliberations

The subgroups 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 subgroup 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 concurrence

Assessment of the Organizational Excellence (OE) Strategic Outcome Goal (New for 2004)

For the first time this year, Organizational Excellence (OE) is a specific NSF strategic outcome goal. We appreciate that NSF has included this goal at the urging of the Advisory Committee for Business and Operations (AC/B&O) since it is a key enabling goal for the outcome goals of People, Ideas, and Tools

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

Following a discussion with the AC/B&O in late March, an assessment of the three indicators was prepared by NSF staff and shared with that Committee for review and comment. Subsequently, a conference call was held with that Committee, the draft assessment was revised based on its comments, and a letter was transmitted to NSF with the results of the AC/B&O deliberations. The AC/B&O supported NSF's determination that the agency had demonstrated significant achievement for the three indicators it considered. The AC/B&O also made a number of comments to improve the approach, methodology and analysis for the assessment of performance in subsequent years. The letter and the revised assessment are found in Appendix II. The OE subgroup of the AC/GPA reviewed the letter and the assessment and performed its own review of the merit review indicator. The results of this analysis were presented to the full AC/GPA for its consideration.

FOUNDATION-LEVEL SUMMARY OF FY 2004 INVESTMENTS

The Committee was asked to provide Foundation-level comments on:

- **The R&D criteria of quality and relevance of the accomplishments reported in FY 2004.**
- **Innovative, high risk, and multidisciplinary research and education in NSF's portfolio of accomplishments reported in FY 2004.**

As noted previously, the Committee relied on numerous and varied sources of information to do its work. In addition, because members of the Committee, both individually and collectively, possess deep familiarity with various aspects of NSF's portfolio, the Committee could complement these data sources with its own expertise and experience in crafting this independent assessment.

Quality and Relevance

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

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

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

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

resist the corrosive influence of these forces and to continue to support and expand competitive merit review across the Federal Government's research portfolio.

Innovative, High Risk, and Multidisciplinary Research and Education

With regard to innovative, high risk, and multidisciplinary research and education, the Committee saw evidence of accomplishment. However, the Committee notes that the term "high risk" with regard to research is still not clearly defined.[1] It was not always clear to the Committee what characteristics NSF staff (program officers) making the designation of "high risk" were using to indicate which specific projects in the portfolio were deemed to be high risk. One subgroup attempted to develop criteria for this term so as to more clearly delineate examples from its portfolio. We offer those criteria as ones that NSF might consider as part of a broader discussion of this issue. "High risk research" might be assessed based on:

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

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

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

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

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

Other Issues for Consideration

At our meeting, the Committee expressed its concerns about the effect of decreasing award rates (often called "success rates") across the Foundation on those writing proposals. While these rates vary quite widely by division and program, the overall trend is downward -- from 32 percent in FY1999 to 27 percent in FY 2003. In addition, it appears from our analysis of the merit review indicator that there may be issues of consistency as proposals are submitted, declined (but encouraged to resubmit after addressing reviewer comments), and then resubmitted by investigators – only to be declined again for completely different reasons. NSF should attempt to gather more than anecdotal data on this phenomenon to test its validity and determine whether action is needed.

The Committee recognizes and applauds NSF for its efforts to increase the average award size. However, this inevitably increases the tension between award size and award duration and also limits the award rate even further in many programs. We have no ready solution for this set of competing parameters, but we urge continued attention to the impacts, both positive and negative, on the performance of the portfolio and NSF's ability to manage and oversee it.

NSF has made significant progress in increasing the participation of underrepresented groups and institutions in its programs (see discussion under People, Indicator 1). This is welcome news. Yet more remains to be done to increase not only the participation of underrepresented groups as Principal Investigators, but as reviewers and panelists. NSF should consider whether it should make some effort to examine the career trajectories of individuals funded not only through the Education and Human Resources Directorate but throughout the Foundation. NSF should also use every opportunity to highlight in its entire portfolio (that is, not limited to the People outcome goal) the accomplishments not only of these individuals, but also of those developing scientists and engineers who represent the next generation of researchers and scholars.

The Committee also recognizes that NSF's budget must have a reasonable and recognizable structure in order to provide a framework for the budget, award, and assessment processes. However, as science and engineering evolve, NSF should also evolve its organizational and budget structure to help optimize its future investments. We applaud innovative experiments such as the Emerging Frontiers "virtual division" in the Biological Sciences Directorate. This novel approach to finding and funding new areas of research appears to be workable and effective. The Committee believes that more of this kind of organizational experimentation should and could be done with NSF with no diminution in the quality of the research portfolio. We are not advocating wholesale reorganization or "faddish" restructuring. Rather, the Committee believes a combination of "thoughtful inertia" and "careful organizational change" can be both effective and performance enhancing. This issue might also be examined by the National Science Board in the context of continuing organizational improvement.

Lastly, the Committee notes that for three years it has been asked to determine whether NSF has demonstrated "significant achievement" in annual progress toward its strategic outcome goals. Toward this end, the Committee has looked at innumerable examples of NSF-supported projects, used the analyses of other external review committees (the COVs) and NSF's own management information, and then relied on its individual and collective expert judgment. However, we find ourselves increasingly asking a "first principles" question; that is, what might be an objective standard (or standards) that constitutes "significant achievement." This is not a trivial point. The current assessment process relies on the Committee's ability to distinguish significant achievement from the lack of it (which we believe is reasonable), but over time the gradation of accomplishment will likely be much more nuanced than this. As NSF begins the process of revising its overall Strategic Plan, the Committee believes that this issue is worthy of some additional reflection.

PEOPLE Strategic Outcome Goal

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

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

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

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

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

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

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

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

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

Assessing Results: Under this performance indicator, NSF is committed to promoting greater diversity by raising the participation of underrepresented groups and institutions in its own programs. Several major programs that contribute to achievements in this area were represented in the nuggets, including EPSCoR (Experimental Program to Stimulate Competitive Research) and the Louis Stokes Alliances for Minority Participation (LSAMP) Program.

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

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

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

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

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

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

The level of innovation is high in activities that support this performance indicator, since reaching out to underrepresented groups demands creativity and new ideas. Data in the Merit Review Process Report, 2003 (an NSF report to the National Science Board) indicate that since 1999, proposal submissions from members of underrepresented minorities have grown faster than the NSF overall number. However, proposal submissions from women have grown more slowly than the NSF overall number. Success rates for proposals submitted are virtually the same across groups.

The NSF FY 2005 Budget Request to Congress estimates that in FY 2003 and FY 2004 more than 200,000 people were involved in NSF activities, including about 31,000 senior researchers, 14,000 other professionals, 6,000 postdoctoral associates, 28,000 graduate students, 35,000 undergraduate students, 13,000 K-12 students, and 85,000 K-12 teachers. The NSF project reporting system is now gathering demographic information on principal investigators and other participants on a voluntary basis. Data are available for about a quarter of project participants for the period 1997-2000. They indicate that the percentage of minority participants rose from 4.3 percent in 1997 to 4.9 percent in 2000, an increase of 14 percent. The percentage of female participants increased from 28.9 percent in 1997 to 30.6 percent in 2000, a 6 percent increase.

PEOPLE GOAL -- Indicator P2: ***Support programs that attract and prepare U.S. students to be highly qualified members of the global S&E workforce, including providing opportunities for international study, collaborations, and partnerships***

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

Four investigator-driven research projects are illustrated that have clearly had an impact on student activities internationally. The first started with a planning visit and was followed by a workshop organized by Kate Miller at the University of Texas at El Paso

(0118594, 0325020). This international research collaboration has opened up research opportunities for geologists in a new part of the world, permitting U.S. graduate students to participate in research in the Kingdom of Bhutan in the Himalayan-Tibetan mountain range. This seismically active part of the world has only recently been opened up to Western investigators. Dr. Miller and her graduate students have been able to work side-by-side with Bhutanese scientists to obtain the first detailed seismic and geodetic measurements in this portion of the Himalayan-Tibetan mountain range. This is an extraordinary opportunity for students to work in an isolated and exotic part of the world in collaboration with indigenous people who share similar scientific interests but very different cultural and language backgrounds.

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

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

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

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

The range and array of international activities that are facilitated through the NSF are truly impressive. There is no part of the world that is not touched by the global

nature of research efforts undertaken by NSF-sponsored U.S. students and researchers. The value of these efforts to our nation and the world is enormous, especially at a time when we may be losing ground in terms of bringing international students and scholars into the United States.

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

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

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

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

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

An innovative method of teaching known as Process Oriented Guided Inquiry Learning (POGIL) is an example of college-level adoption of an innovative method of teaching (0231120). This technique replaces the traditional lecture format with a learner-centered approach in which students explore data, search for patterns, develop

concepts to explain these patterns, and then apply these concepts to new situations. The technique has been applied to general chemistry, organic chemistry, and physical chemistry that, traditionally, have had high rates of attrition. The effectiveness of this approach has been demonstrated at the University of New Mexico, SUNY Stony Brook, Franklin and Marshall College, Carleton College, Washington College, and Catholic University. Through national dissemination, it is hoped that a critical mass of practitioners will change the culture in chemistry and increase the awareness and appreciation of learner-centered pedagogies.

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

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

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

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

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

High Public Interest – Information Transfer

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

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

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

General Public Doing Science

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

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

Education

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

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

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

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

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

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

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

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

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

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

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

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

- NSF should strongly consider encouraging the increased use of the Research Experiences for Undergraduates (REU) Program to encourage more involvement of undergraduates in projects related to People. This is especially true for international and multicultural projects.
- In order to expand the number of projects related to the preparation of U.S. students to be highly qualified members of the global S&E workforce, faculty should be encouraged to interact with existing offices and organizations on their campuses that coordinate study abroad.
- NSF should consider bringing to the forefront excellent activities related to the PEOPLE goal as models even if NSF does not fund these programs.
- NSF needs to support research on the factors that affect the ability to attract graduate students to the United States. Currently there is mostly anecdotal information that does not lend itself to the development of strategies to address the issue in ways that will be effective in the long term.

IDEAS Strategic Outcome Goal

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

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

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

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

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

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

For example, one SGER project at MIT proposed a totally new way of delivering biomedical agents to the body by developing a new nanotechnology. We believed that it was high risk in that the research was conceptual, untested, and the project involved an undergraduate (0336770). Another project at Michigan State University proposed to develop a viable synthetic alternative to currently available graft materials for repair of damaged and lost bone tissue (0074439). A third project at Eastern Michigan University involved conducting potentially controversial surveys on religion and politics in countries in the Middle East with a volatile history of relations with the United States (0097282). In general, the proposals we examined that were designated high risk, innovative, or multidisciplinary were either innovative or multidisciplinary and not what we might consider high risk. NSF might consider what barriers the merit review process creates regarding the support of high risk proposals.

In our view, one of the hallmarks of a high risk project is one that attempts something of a different size and scope than has been tried previously. An example is the TeraGrid project (0307136, 0332116, 0122272), a multi-year effort to build and deploy the world's largest and fastest distributed infrastructure for open scientific research. Applications of the TeraGrid include: (i) simulation of the evolution of the universe; (ii) simulation of complex materials shapes, known as gyroids, that have important applications in controlled drug release and biosensors; and (iii) use of computationally intensive genetic algorithms to find the most effective and least costly methods to clean up polluted sites. (The TeraGrid project is also cited under Tools Indicator T3.)

A project might also be considered high risk because it tries to do something with potentially large benefits for society that others have tried to do and failed. An example of this is a project that led to the discovery of a technique to produce the first white-light polymeric LED (0209651). A polymeric LED having pure white light (according to the international chromaticity diagram) has been an intensely pursued research dream for many years; many groups have tried to achieve white light in LEDs without success. A grantee of the Polymers Program in the Division of Materials Research, Fred Wudl at UCLA, working in collaboration with his colleague Yang Yang, has recently succeeded in creating polymeric LED having pure white light. This discovery will enable the production of "cold light" light bulbs that will emit brighter and much cooler light than the standard incandescent lamps and have a longer lifetime. (This award is also cited under Ideas Indicator I3.)

The ability to design proteins containing particular folds for structure or active sites for function would provide tissue engineers and physicians treating metabolic and infectious diseases with powerful tools that do not exist at the current time. CAREER awardee Chen Zeng at George Washington University, in collaboration with colleagues at NEC, Princeton, and Beijing University, has carried out theoretical research and developed a "principle of protein folding" (0094176, 0313129). This group has extended this principle to the development of algorithms for protein folds. This work is multidisciplinary and draws on expertise in statistical physics, computational science, and molecular biophysics to construct the suite of algorithms and computational tools for protein design and modeling. It is extremely high risk because proteins are complex structures and the proteins designed by the procedure may not have the properties the investigators' theory predicts. If, however, the method proves successful, even if only in part, the work could have a large impact on protein engineering.

At the current time, light sources at 13nm and/or 4nm, important for biological imaging, can only be obtained from inconvenient, extremely expensive, building-size synchrotron facilities. Graduate students Emily Gibson and Ariel Paul, along with researchers at the University of Colorado, have demonstrated that it is now possible to make practical, low cost, compact (table-top) laser-like sources for these wavelengths (0099886). This breakthrough promises to make these sources widely available for the first time and allow for the development of ultra powerful desktop microscopes that could visualize processes happening within living cells or perhaps even allow scientists to understand how pharmaceuticals function in detail. This work was high risk because its success depended on concurrent advances in nonlinear optics, ultra fast science, as well as extreme ultraviolet and soft-X-ray technologies.

Multidisciplinary Research: Efforts to fund multidisciplinary projects appear uneven across programs. For example, the COV report on the MPS Office of Multidisciplinary Activities (OMA) raises concerns about the relative level of participation in this Office by the various MPS divisions. The COV found that OMA has been effective in the Astronomy, Chemistry, and Physics Divisions, but that both the Mathematics Division and the Materials Research Division are less dependent on OMA because each has its own interdisciplinary programs. Within the Social, Behavioral and Economic Sciences (SBE) Directorate, there are several programs that are inherently multidisciplinary, but at least one COV report expressed concern that interdisciplinary initiatives were diluting support for core disciplines. The Economics, Decision and Management Sciences Cluster COV report observed that "evidence exists that large and multidisciplinary efforts have been successful in the natural and physical sciences and in engineering, but is not obvious that similar success in the social sciences and

economics is likely." The COV expressed concern that "attempts to integrate science across even broader disciplinary boundaries can result in dilution of funding and programmatic energies without sufficiently concentrated support for success."

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

Two examples illustrate the first type of multidisciplinary project. One is a workshop in 2003 that brought together 25 scientists from a variety of disciplines in an attempt to synthesize knowledge across disciplines in Arctic sciences (0101279). The other involved a workshop and onsite field research at the World Trade Center and the Pentagon immediately after the attacks of September 11, 2001 (0203371). The resulting volume, Beyond September 11: An Account of Post-Disaster Research, contains contributions from scientists and engineers in disciplines such as civil, geotechnical, and structural engineering, decision science, geography, psychology, sociology, and urban planning.

An example of the second type of project is "Advanced Single Molecule Techniques on DNA-Protein Interactions" (0134916), funded by the CAREER Program to two physicists at the University of Illinois at Urbana-Champaign. Together with mathematicians and biologists, Taekjip Ha and Paul Selvin are using single molecule fluorescence detection to study the molecular-level function of the biological molecular motor, myosin V. A report of the results, "Myosin V Walks Hand-Over-Hand: Single Fluorophore Imaging with 1.5-nm Localization," was published in Science (v. 300, 27 June 2003: 2061-2065).

One example of the third type of project is "Toward a Descriptive Science of Learning Practices," described more fully under Indicator I2 below (0126104). Another is a collaboration of researchers in physics, mathematics, and material sciences at the University of Michigan to further the development of quantum computation (0114336, 0305837). This research is supported by the Division of Mathematics and by the Physics Division's Physics Frontiers Center program.

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

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

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

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

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

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

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

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

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

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

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

IDEAS GOAL -- Indicator I2: ***Encourage collaborative research and education efforts – across organizations, disciplines, sectors, and international boundaries***

NSF has supported several projects that encourage collaborative research and education efforts across organizations, disciplines, sectors, and international boundaries. Several programs are inherently interdisciplinary -- for example, within the Social, Behavioral and Economic Sciences (SBE) Directorate, the Decision, Risk and Management Science program; the Innovation and Organizational Change (IOC) program; the Law and Social Science (LSS) program; the Methodology, Measurement and Statistics program; the Science and Technology Studies Program; and the Societal Dimensions of Engineering, Science, and Technology Program sponsor research that

crosses traditional disciplinary boundaries. The COV report on the LSS programs describes the cross-fertilization process that results from this funding:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

IDEAS GOAL – Indicator I5: ***Provide leadership in identifying and developing new research and education opportunities within and across S&E fields.***

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

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

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

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

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

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

The underlying theme of the following examples is the creation of new knowledge and skill sets by learning differently together. For example, the research team of Nersessian and Newstetter at Georgia Tech studied and analyzed the Biomedical Engineering Laboratories (BME), organizations already well-known for their high degree of innovation in order to unlock cognitive keys that could be not only transferred but integrated into undergraduate biomedical engineering curriculum (0106773). "Hard-wiring" these lessons and approaches into the curriculum, one has a greater expectation of producing future student cohorts - ones better equipped to conceive of, implement, and carry to completion more complex and interdisciplinary research projects.

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

Two key components in accelerating progress in high priority S&E areas are the seamless integration of the social sciences and pushing “results” down to K-12 grades. Six Degrees: The Science of a Connected Age, by Duncan J. Watts, a CAREER award recipient, does both (0094162). This book is written at a level appropriate for an audience of school children and explains the structure of social networks. Via email projects, school children discover for themselves the "six degrees of separation." Watts has done more than merely introducing the public to social networks; he has developed new theory and applications of complex social networks by bringing together newly available economic and sociological data with enhanced computational methods. In so doing, he has not only drawn upon but has contributed to fields as diverse as physics and biology. This research (and resultant book) have provided people with new perspectives and critical thinking skills as evidenced by the enormous public interest in understanding social networks and how they explain such phenomena as epidemics, stock market bubbles, and personal relationships. (This project was also described under People Indicator P4.)

TOOLS Strategic Outcome Goal

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

The Committee continues to be concerned about the point made in the FY2003 AC/GPA Report concerning the tension between ongoing commitments and new awards. This relates to the “big science/small science” issue discussed by NSF Acting Director Bement at our meeting and is intensified by the overextended budget. We feel that budgeting and planning for the operation of major facilities should be more transparent throughout the agency. Once a facility becomes operational, the funding burden shifts to the divisions, pressuring their budgets. It seems that planning for this future pressure could use attention.

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

Detailed discussions of the five indicators for this outcome goal follow.

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

The Committee had some difficulty interpreting this meaning of this indicator. Few grants actually satisfied the “and” conjunction of “researchers, educators, and students.” It appears that NSF program officers interpreted the conjunction as a disjunction (or), and we followed suit. With that caveat, we found that four nuggets indicated significant achievement, over a broad range, from mathematics to geology to computational biology to networks. We urge that NSF clarify this issue at its earliest opportunity.

The Institute for Mathematics and Its Applications (IMA) at the University of Minnesota is one of several excellent mathematical sciences research institutes funded by NSF (0307274, 9810289). These institutes are especially well positioned to help expand opportunities for U.S. researchers who want to explore directions in exciting new interdisciplinary areas. In June 2003, the IMA launched two activities to assist established mathematicians to make such changes and to increase the impact of their research. The first is a series of summer crash courses designed to introduce mathematical scientists without applied background to an active area of interdisciplinary research through tutorials and work with more established researchers. The inaugural course attracted 27 researchers and focused on cellular physiology. The second activity augments the existing visiting membership of the IMA during its long-term annual

programs by adding a few resident memberships reserved for mathematical scientists seeking new research directions in line with program topics. The first such members participated in the 2003-2004 program on "Probability and Statistics in Complex Systems: Genomics, Networks, and Financial Engineering." These experiments—and perhaps others to follow—are fine examples of how the mathematical sciences research institutes can help to maximize the productivity and impact of mid-career researchers.

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

The GRASP computer program at Columbia University for studying membrane proteins makes the important study of complex electrostatic surfaces of proteins easy and even user-friendly (9808902). It has become one of the most widely used programs in structural biology, to the point where nearly every relevant publication includes a GRASP image, attesting to its widespread adoption. The three-dimensional structure of proteins allows the GRASP algorithm, developed by the staff at Columbia University, to calculate the electrical potentials of a protein and map them onto the protein surfaces. Through much analysis, it has been accepted that these GRASP images play an important role in recognizing many protein-protein interactions. This provides the basis for understanding the physical-chemical rules that govern these interactions, and for using these rules to predict the regions on a protein’s surface involved in intermolecular recognition. A web interface to a database of protein-protein interfaces (the GRASP structure server) has made this tool accessible and therefore useful to researchers and educators throughout the world.

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

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

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

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

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

million galaxies, with redshift distance measurements for more than 100,000 of them. The second, DR2, was made available to the astronomical community in early 2004. This research project encourages international scientific collaboration and places the United States at the forefront of cosmological astrophysics.

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

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

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

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

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

2. High-speed Networks. It is self-evident that immense computational resources need networks that can deliver them to scientists at unprecedented speeds. EuroLink (9730202) and TransPAC (9730201) are exemplary programs that have achieved five Gbps via innovative optical network architectures, the former linking North America to Europe, and the latter to Tokyo. The connection in the United States is to NSF's very

high-performance Backbone Network Services (vBNS). Innovations in administrative structures, hardware, and software are all necessary to advance the state of this art. Especially notable are the small research projects that are pushing the networking envelope and feeding into the national facilities, such as the five-fold speed increase of FAST TCP, and the thousand-fold energy reduction of narrow-beam wireless (0225379).

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

NSF has supported a wide range of research that contributes to this indicator and the impact appears to be both highly valuable and far-reaching. Some of the work may be categorized as building a supporting infrastructure, for example construction tools to search for critical information efficiently, which will facilitate high quality decisions about policy and resource allocation. Other work is of a more direct technical nature, such as the invention of a tool that will assist in a particular resource allocation problem, leading to more informed decisions of the same type. The nuggets described below were selected to illustrate the range of awards that have contributed in different ways to this indicator. (We also considered the award "Stochastic Network Interaction Models for Homeland Security" (0228419) on optimal sensor placement for detecting sensitive materials, an intriguing combination of a compelling national security problem and state-of-the-art technology, which was one of several examples of work that was relevant to but somewhat tangential to the indicator.)

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

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

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

Another research project studied the determinants of patenting behavior and the effect of patenting on R&D efforts in the United States and Japanese manufacturing sectors and also the effect of the patenting and licensing of research tools on biomedical innovation. Based on careful modeling of data, a number of findings were reached that have implications for policymakers in both government and industry. A summary of the research was widely disseminated in Science ("Working Through the Patent Problem," v. 299, 14 February 2003: 1021).

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

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

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

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

The need for monitoring large and changing environments covers such diverse fields as ecology, atmospheric science, public health, and national security. Static, non-autonomous sensors do not provide investigators with the power and flexibility that they

need. Research at the Center for Embedded Networked Sensing at UCLA seems to have overcome these difficulties (0120778). Utilizing a network of fixed and mobile nodes, a self-aware sensor network is created that can reconfigure itself in order to continually optimize its performance. Successful tests of the system have already been run, collecting data from within a forest environment not easily accessible by humans. The project also impacts K-12 education in that it provides students access to remote sensors that they may use to carry out investigations of their own.

ORGANIZATIONAL EXCELLENCE (OE) Strategic Outcome Goal

An agile, innovative organization that fulfills its mission through state-of-the-art business practices. NSF is successful when significant achievement is demonstrated for the majority (three out of four) of the following performance indicators:

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

Summary

This strategic outcome goal was added to the NSF Strategic Plan for FY2003-2008. This is a major step forward in recognizing the linkages between excellence in advancing science and excellence in organizational development. Within the OE goal, the indicators "mirror" the P, I, T structure of the other strategic outcome goals. The Human Capital indicator is the "people" dimension of OE, the Technology-Enabled Business Processes is the "ideas" dimension of OE, and the Performance Assessment and Merit Review indicators are the "tools" dimension.

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

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

With regard to Merit Review, the OE subgroup reviewed data and information from the Report to the National Science Board on the National Science Foundation's Merit Review Process, Fiscal Year 2003, supporting documentation provided by the NSF including a customer survey conducted by Booz, Allen, Hamilton, and the reports from a number of Committees of Visitors (COVs). We concluded that NSF had demonstrated significant achievement for this indicator. While the Merit Review Process will always, in our view, require vigilance and a commitment to continuous improvement, when taken

as a whole and when one looks at the results as illustrated in the People, Ideas, and Tools portfolios, clearly, the process remains a major positive force in advancing the frontiers of science, mathematics, and engineering.

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

Assessment of the Merit Review Process

In general the Merit Review Process (MRP) is impressive -- handling 40,075 proposals resulting in 10,844 awards, an award rate of 27 percent. Standard grants comprise 60 percent of the awards with the remaining 40 percent comprised of continuing grants. In 2003, the number of proposals received from female principal investigators (PIs) increased by nine percent and the number received from minority PIs increased by four percent. Proposal submissions from new PIs increased 17 percent and represented 19 percent of the total awards made.

The distribution by sector of the awards from the NSF remains relatively unchanged over the past three years. The top 100 universities still receive the overwhelming majority of all NSF awards (74 percent). The median grant size increased 16 percent in FY2003 to $100,000 with a median duration of 2.9 years. The long-standing NSF goal for duration has been three years and NSF hopes to increase this parameter further to four years over time.

Proposals are reviewed primarily by three mechanisms: mail reviews only, panel reviews, and mail-panel combination. The use of the panel and mail-panel combination is increasing while the use of mail reviews only continues to decrease (down to 11 percent in 2003.) Including all mechanisms of review, the average number of reviews per proposal for 2003 was 6.3. Selected from the electronic database of 295,000 reviewers, 54,000 reviewers participated in the merit review process, and of those, 8,000 were first time reviewers. The NSF goal of processing 70 percent of all proposals within six months of submission was once again exceeded in 2003 (77 percent, up from 74 percent in 2002).

One of NSF's original GPRA goals was to increase reviewer and program officer (PO) attention to *both* of the merit review criteria. It was noted in the two previous AC/GPA reports that consideration of the broader impact of the research continued to be somewhat inadequate. In 2003, 90 percent of the reviewers commented on both merit review criteria, up from 84 percent in 2002 and 69 percent in 2001. Thus, there has been considerable progress on addressing the two criteria. However, the quality of response to the broader impacts criterion is still an issue. Several COV reports as well as comments from the AC/GPA indicate that the discussions of this criterion frequently lack substance and appear to be cursory at best, even though NSF now requires a one-page discussion of both criteria in the project summary of the proposal. In 2003, 276 proposals were returned because this discussion was missing completely. The AC/GPA

finds that the review of the broader impacts criterion remains a challenge for most reviewers. We noted some inconsistency in the completeness and quality of this part of the review and we recommend that NSF continue to focus on this issue.

The "customer survey" performed by Booz, Allen, Hamilton surveyed a large number of both awardees and those whose proposals had been declined. In general, all respondents were satisfied with the mechanics of the process (i.e., FastLane, interactions with POs, time to prepare proposals, etc.) However, the respondents were less satisfied with the timeliness, quality, and perceived fairness of the review process. In general, respondents wanted reviews in about four months, not the current six. In addition, the survey indicated that NSF should do a better job of providing feedback to proposers, increasing the level of reviewer accountability, and paying more attention to the consistency of reviews both within a particular review cycle and over time (i.e., for resubmissions). It should be noted that those whose proposals were declined were more likely to be dissatisfied than awardees. More generally, COV reports also indicate that more specific feedback to the PIs is desirable, including strengths, weaknesses, and suggestions for improvement. Several of those reports recommended tutorials on review preparation with examples of helpful reviews (for prospective reviewers and panel members).

Also noted by the COV reports was some variability in the documentation for funding decisions that are outside of the normal review process and mechanisms, for example, those pertaining to workshops and Small Grants for Exploratory Research (SGER). The COVs believed that documentation should detail the decision making process for these awards as well as for funded proposals that received low reviewer ratings and highly rated proposals that were declined. The AC/GPA recognizes that there are many factors in addition to proposal ratings that must be considered by the PO in the decision making process. It would be most helpful if explanations for all decisions were included in the proposal jacket. The AC/GPA further recommends the examination of the success of resubmissions as a function of the comments of the previous review, panel constitution, and PO.

The AC/GPA discussed the issue of whether the MRP may filter out "high risk" and "innovative" proposals. We came to no conclusion about this issue in the brief time we had to consider it. However, we did conclude that a reasonable level of flexibility in the review process must be maintained to allow POs, division directors, and directorates to support proposals addressing strategic and emerging needs, issues, and directions.

The AC/GPA also recognized that the PO is the key to the success of the MRP in that he/she selects the reviewers, composes the panels, and manages the process of review. The typical PO processes 105 proposals each year and spends 55 percent of his/her time on the review process (source: Booz, Allen, Hamilton workload survey of NSF staff). Since this survey was the first of its kind ever performed, we have no basis on which to assess whether more than half of an average PO workyear on proposal review is too much or too little, but it does seem to us like an inordinate amount of time, especially given the other important duties that a PO should be attending to, e.g., program development, award management and oversight, outreach and communication, performance assessment). The AC/GPA recommends that NSF continue to track the amount of the PO's workload that is devoted to the MRP. In the past ten years the budget of the NSF has nearly doubled and the number of proposals has increased significantly, yet the number of NSF staff has only increased by four percent. While the specific effects of this budgetary growth on the PO workload are not exactly known, the

AC/GPA strongly recommends that NSF examine the effects of increased proposal submissions and the level of staff support on the PO workload. The AC/GPA also applauds NSF's experimentation with "virtual" panels and program officers and encourages the continued use of such mechanisms to improve engagement with the science and engineering community.

The AC/GPA is concerned about the apparent lack of baseline data on the demographics of both reviewers and PIs. We urge NSF to redouble its efforts to engage a diverse pool of reviewers in the MRP. In addition, the Committee understands that while the PI database and the reviewer database are currently separate, easy and comprehensive retrieval of systematic and holistic demographic information about reviewers and PIs remains desirable and necessary.

The AC/GPA discussed the effectiveness of the MRP for the review of interdisciplinary/multidisciplinary proposals. We debated without resolution whether the organizational structure of NSF (relatively autonomous directorates with disciplinary divisions) promotes effective reviews and uniform processes for such proposals. We suggest that this issue is ripe for additional discussion by NSF's senior leadership with an eye toward creating some set of consistent review practices for these types of proposals across the Foundation. The AC/GPA also debated briefly without resolution the extent to which the NSF should drive academic research agendas.

In summary, we conclude that the Merit Review Process is effective in the processing and review of a large volume of proposals, in the engagement of a broad and diverse segment of talent in the NSF's science and engineering enterprises, and in supporting the advancement of the frontiers of science and engineering. The recommendations put forth by the AC/GPA reflect our strong view that NSF should continue to examine and update the merit review process as its science and engineering communities evolve in the 21st century.

COMMENTS ON THE PROCESS AND THE COMMITTEE'S WORK

The AC/GPA Committee is enormously impressed and pleased with the improvements that NSF has made in the process this year. It is clear that our recommendation last year to have the subcommittees "meet" in advance and do the indicator analysis prior to the meeting was heeded. The teleconferences that were held with the chairman, vice-chairman, and subgroup chairpersons as well as those with each of the subgroups facilitated the completion of most of the indicator analysis well ahead of the meeting. This enabled more substantive and meaningful discussions at the meeting and certainly contributed to the increased timeliness of the submission of the final report. In addition, the improvements enabled the Committee to take a page out of the organizational excellence book and become a "learning committee" over the course of its meeting – a truly rewarding experience. We are most grateful for the time and effort of the many NSF staff that made this possible.

The Committee thanks NSF for other positive changes including:

- The early incorporation of comprehensive web-based data, links, and reports on the AC/GPA website.

- The opening of the website three months prior to the meeting.

- The inclusion of a "member documents" page on the website that allowed the selection of "nuggets" and the sharing of comments and facilitated the committee members' completion of review of their assigned areas prior to the meeting.

- The improvement in the database of accomplishments (aka "nuggets") continues. However, we still find a great deal of variability in length and in consistency of presentation. We again urge that NSF emphasize the importance of a jargon-free writing style for the accomplishments and that there be even more attention to the relationship of accomplishments to the indicators they are supposed to illustrate. We also believe it would be helpful if, in future, the database included information on project duration and level of funding for each of the accomplishments. This information provides important contextual information for the Committee's assessments.

- The improved sampling across NSF's programs, particularly the 30 largest programs, to assure a more representative set of accomplishments across programs, divisions, and directorates.

- The refined charge to include only retrospective proposals and activities, thereby limiting the volume of material to be reviewed by the Committee and subsequently allowing more thorough and thoughtful examinations and conversations.

- The Committee also appreciated that NSF responded specifically and in writing to our comments and recommendations of last year. The "you said this – we did that" information provided to the Committee helped shape our discussion of future improvements.

- We recognize that the process used this year for assessing the Organizational Excellence outcome goal was rather novel. The use of a self-assessment by NSF with review and comment by the most relevant advisory committee (AC/B&O) seemed to be effective and to provide NSF with useful feedback. The assessment by AC/GPA of the Merit Review indicator of this outcome goal is consistent with the work of our committee in previous years. NSF should continue to examine the most effective ways of integrating annual assessment of organizational excellence into assessment of portfolio performance.

Lastly, the Chair and Vice Chair specifically wish to thank their hard-working committee members and the able chairs of each of the subgroups, David Farber, Gloria Rogers, and Tim Tong. It is always a pleasure to work with a group of smart, motivated, and assiduous individuals and this Committee typifies those traits. Each person "did their homework" and came to the meeting prepared to discuss, debate and synthesize the collective results of their work. NSF is fortunate to have such people in its "corner" and it has been an honor to serve as their leaders.

Appendix I
List of Accomplishments (Nuggets) Cited

People

0244179
Award Title: ASSURED - Agricultural Science Summer Undergraduate Research Education & Development Project
PI Name: Paul Bosland
Institution Name: New Mexico State University

0070982
Award Title: Deaf Initiative in Information Technology (DIIT)
PI Name: Donna Lange
Institution Name: Rochester Institute of Tech

0123149
Award Title: Sustained Economic Growth of the Oglala Lakota Nation through Development of the Technological Infrastructure
PI Name: Michael Fredenberg
Institution Name: Oglala Lakota College

0243399
Award Title: Partial Support for the 2003 Annual Conference of the National Society of Black Physicists (NSBP) Diversity Projects; Spellman College; Atlanta, GA
PI Name: Apriel Hodari
Institution Name: National Society of Black Physicists

0209478
Award Title: Enhancing Diversity in Graduate Education (EDGE): A Transition Program for Women in the Mathematical Sciences
PI Name: Rhonda Hughes
Institution Name: Bryn Mawr College

0118594
Award Title: US-Bhutan Planning Visit: Seismotectonics and Structure of the Bhutanese Himalaya
PI Name: Kate Miller
Institution Name: University of Texas at El Paso

0325020
Award Title: US-Bhutan Workshop: Seismotectonics and its Relationship to Natural Hazards in the Bhutanese Himalaya
PI Name: Kate Miller
Institution Name: University of Texas at El Paso

0223920
Award Title: REU Site: The Nyanza Project--Interdisciplinary Tropical Lake Studies Associated with the International Decade of East African Lakes (IDEAL)
PI Name: Andrew Cohen
Institution Name: University of Arizona

0238407
Award Title: Microbial Observatories: Collaborative Research: Kamchatka, a Geothermal Microbial Observatory
PI Name: Juergen Wiegel
Institution Name: University of Georgia Research Foundation Inc

0202581
Award Title: International Research Fellowship Program: Archaeological Research and Development at the Ancient Maya City of Pusilha, Belize
PI Name: Geoffrey Braswell
Institution Name: Braswell, Geoffrey E

0310315
Award Title: NSF East Asia Summer Institutes for US Graduate Students
PI Name: Abby Morgan
Institution Name: Morgan Abby W

0115599
Award Title: Columbus Urban Systemic Program (CUSP)
PI Name: Gene Harris
Institution Name: Columbus Public Schools

0231120
Award Title: Process Oriented Guided Inquiry Learning
PI Name: Richard Moog
Institution Name: Franklin and Marshall College

9553727
Award Title: Northwest Center for Emerging Technologies: New Designs for Advanced Technological Education
PI Name: Douglas Brown
Institution Name: Bellevue Community College

9813446
Award Title: NorthWest Center for Emerging Technologies: New Designs for Advanced Information Technology Education
PI Name: Neil Evans
Institution Name: Bellevue Community College

0101657
Award Title: E-Portal to Information Technology Education and Careers: A Dissemination Focal Point @ NWCET for Students, Educators, Business, Policy Makers, and Government
PI Name: Peter Saflund
Institution Name: Bellevue Community College

0127488
Award Title: National Computational Science Institute
PI Name: Robert Panoff
Institution Name: Shodor Education Foundation Inc

0328525
Award Title: A TeacherTech Program for Pittsburgh
PI Name: Beverly Clayton
Institution Name: Carnegie-Mellon University

0094162
Award Title: CAREER: Theory and Applications of Complex Social Networks
PI Name: Duncan Watts
Institution Name: Columbia University

9253378
Award Title: Earth & Sky Radio Series
PI Name: Deborah Byrd
Institution Name: Byrd & Block Communications Inc

0128985
Award Title: Earth & Sky's "Edge of Discovery" Radio Series for NSF's Public Understanding of Research Program
PI Name: Deborah Byrd
Institution Name: EarthTalk Incorporated

0125087
Award Title: Earth & Sky's 'I Wonder' series
PI Name: Deborah Byrd
Institution Name: EarthTalk Incorporated

0087760
Award Title: Citizen Science Online
PI Name: John Fitzpatrick
Institution Name: Cornell University - State

0326631
Award Title: The Alaska Lake Ice and Snow Observatory Network (ALISON): A Statewide K-12 and University Science Education and Research Partnership
PI Name: Martin Jeffries
Institution Name: University of Alaska Fairbanks Campus

0119934
Award Title: Earth Science Pipeline: Recruiting and retaining under-represented ethnic groups in Earth Sciences
PI Name: Alan Smith
Institution Name: California State University-San Bernardino Foundation

0335411
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

0226948
Award Title: Mathematical ACTS
PI Name: Richard Cardullo
Institution Name: University of California-Riverside

0233505

Award Title: Longitudinal Design to Measure Effects of MSP Professional Development in Improving Quality of Instruction in Mathematics and Science Education
PI Name: Rolf Blank
Institution Name: Council of Chief State School Officers

0002778
Award Title: Science Analysis for TIMSS-R Videotape Classroom Study
PI Name: Eugene Owen
Institution Name: Department of Education

9602229
Award Title: Evolution from DNA to the Organism: The Interface Between Evolutionary Biology and the Mathematical Sciences
PI Name: Carlos Castillo-Chavez
Institution Name: Cornell University - Endowed

0219924
Award Title: ITR-The ARCHway Project
PI Name: Kevin Kiernan
Institution Name: University of Kentucky Research Foundation

0126104
Award Title: Toward a Descriptive Science of Learning Practices
PI Name: Timothy Koschmann
Institution Name: Southern Illinois University School of Medicine

Ideas

0336770
Award Title: A New Approach to High-Latitude Research Problems: Nanosystems Neurotechnology Collaboration
PI Name: Patrick Kane
Institution Name: Saoirse Corporation

0074439
Award Title: Bioactive Hydroxyapatite Whisker Composite Ceramic Bone Substitutes
PI Name: Melissa Baumann
Institution Name: Michigan State University

0097282
Award Title: In Search of a Sociopolitical Community: The Cases of Egypt, Iran, and Jordan
PI Name: Mansoor Moaddel
Institution Name: Eastern Michigan University

0307136
Award Title: Terascale Computing System
PI Name: Michael Levine
Institution Name: MPC Corporation

0332116
Award Title: The TeraGrid Proposal: Cyberinfrastructure for 21st Century Science and Engineering
PI Name: Robert Pennington

Institution Name: University of Illinois at Urbana-Champaign

0122272
Award Title: The TeraGrid: Cyberinfrastructure for 21st Century Science and Engineering
PI Name: Francine Berman
Institution Name: University of California-San Diego

0209651
Award Title: The Next Generation Organic Materials Oligoacenes, Heteroacenes and Cyclacenes
PI Name: Fred Wudl
Institution Name: University of California-Los Angeles

0094176
Award Title: CAREER: Statistical Physics of Disordered Systems: A Program for the Development and Application of Exact Combinatorial Algorithms to Extended Systems in Disordered Media
PI Name: Chen Zeng
Institution Name: George Washington University

0313129
Award Title: ITR: A Protocol For Computational Protein Design
PI Name: Chen Zeng
Institution Name: George Washington University

0099886
Award Title: Quantum Control of Coherent EUV Radiation: New Methods for Phase Matching at Short Wavelengths
PI Name: Margaret Murnane
Institution Name: University of Colorado at Boulder

0101279
Award Title: Organizational Support to the U.S. Arctic Science Program
PI Name: Wendy Warnick
Institution Name: Arctic Research Consortium of the U.S.

0203371
Award Title: Workshop on Research Related to the World Trade Center Disaster
PI Name: Rae Zimmerman
Institution Name: New York University

0134916
Award Title: CAREER: Advanced Single Molecule Techniques on DNA-Protein Interactions
PI Name: Taekjip Ha
Institution Name: University of Illinois at Urbana-Champaign

0126104
Award Title: Toward a Descriptive Science of Learning Practices
PI Name: Timothy Koschmann
Institution Name: Southern Illinois University School of Medicine

0114336
Award Title: "FOCUS: Frontiers in Optical Coherent and Ultrafast Science"
PI Name: Philip Bucksbaum

Institution Name: University of Michigan Ann Arbor

0305837
Award Title: Collaborative Research: Dynamics, Stabilization and Control of Nonholonomic Systems
PI Name: Anthony Bloch
Institution Name: University of Michigan Ann Arbor

8008580
Award Title: Econometric Models With Stochastic Variance
PI Name: Robert Engle
Institution Name: University of California-San Diego

8004414
Award Title: Long-Memory Relationships Between Economics Variables Arising From the Aggregation of Dynamic Models
PI Name: Clive Granger
Institution Name: University of California-San Diego

9730062
Award Title: Accomplishment Based Renewal of: Autoregressive Conditional Duration, Arch, Common Features, and Cointegration
PI Name: Robert Engle
Institution Name: University of California-San Diego

8008629
Award Title: Nuclear Magnetic Resonance Microscopy
PI Name: Paul Lauterbur
Institution Name: SUNY at Stony Brook

0209754
Award Title: Arabidopsis 2010: Genomics Approaches to Finding Transcriptional Networks
PI Name: Philip Benfey
Institution Name: Duke University

9820808
Award Title: Optical Sensing Based on Inducible Bacterial Luminescence
PI Name: Sylvia Daunert
Institution Name: University of Kentucky Research Foundation

0241354
Award Title: Investigating the Characteristics and Consequences of Interannual Variations in the Northwest Atlantic's Deep Western Boundary Current
PI Name: John Toole
Institution Name: Woods Hole Oceanographic Institution

0326778
Award Title: Exploring Recent Changes of Ocean Salinity Distributions in the Context of Climate Change
PI Name: Ruth Curry
Institution Name: Woods Hole Oceanographic Institution

0117770
Award Title: Center for Nanoscale Systems in Information Technologies
PI Name: Robert Buhrman
Institution Name: Cornell University - Endowed

0122557
Award Title: ITR/AP: An International Virtual-Data Grid Laboratory for Data Intensive Science
PI Name: Paul Avery
Institution Name: University of Florida

0204877
Award Title: The ATLAS Research Program: Empowering U.S. Universities
PI Name: William Willis
Institution Name: Columbia University

0204786
Award Title: Empowering Universities: Preparation for the CMS Research Program
PI Name: Stephen Reucroft
Institution Name: Northeastern University

9906404
Award Title: GOALI: Development and Evaluation of Innovative FRP Braided Fabric for Strengthening Infrastructures
PI Name: Nabil Grace
Institution Name: Lawrence Technological University

9900809
Funded under: IDEAS

Award Title: First Smart/Innovative Carbon Fiber Reinforced Polymer (CFRP) Bridge in the USA
PI Name: Nabil Grace
Institution Name: Lawrence Technological University

9731643
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

0126104

Award Title: Toward a Descriptive Science of Learning Practices
PI Name: Timothy Koschmann
Institution Name: Southern Illinois University School of Medicine

0326095
Award Title: ITR: Collaborative Research: Using Humanoids to Understand Humans
PI Name: Stefan Schaal
Institution Name: University of Southern California

0325383
Award Title: ITR: Collaborative Research: Using Humanoids to Understand Humans
PI Name: Christopher Atkeson
Institution Name: Carnegie-Mellon University

9981762
Award Title: Collaborative Research: Cultural Models, Values and Networks in Environmental Decisions
PI Name: Scott Atran
Institution Name: University of Michigan Ann Arbor

9910156
Award Title: Collaborative Research: Cultural Models, Values and Networks in Environmental Decisions
PI Name: Douglas Medin
Institution Name: College of the Menominee Nation

0131184
Award Title: Antimicrobial Peptide Defenses in Amphibian Skin
PI Name: Louise Rollins-Smith
Institution Name: Vanderbilt University Medical Center

0210247
Award Title: NIRT: One-,Two- and Three-Dimensional Superstructured Materials from Well-Defined, Complex Nanoscale Components
PI Name: Karen Wooley
Institution Name: Washington University

9876098
Award Title: PECASE: The Economics of Gangs
PI Name: Steven Levitt
Institution Name: University of Chicago

0126167
Award Title: Science Achievement and Health Behavior: High School Curriculum, Social

Context, and Opportunity to Learn
PI Name: Chandra Muller
Institution Name: University of Texas at Austin

9903368
Award Title: Over-complete Signal Decomposition
PI Name: Avideh Zakhor
Institution Name: University of California-Berkeley

0209651
Award Title: The Next Generation Organic Materials Oligoacenes, Heteroacenes and Cyclacenes
PI Name: Fred Wudl
Institution Name: University of California-Los Angeles

0244179
Award Title: ASSURED - Agricultural Science Summer Undergraduate Research Education & Development Project
PI Name: Paul Bosland
Institution Name: New Mexico State University

0119934
Award Title: Earth Science Pipeline: Recruiting and retaining under-represented ethnic groups in Earth Sciences
PI Name: Alan Smith
Institution Name: California State University-San Bernardino Foundation

0119891
Award Title: The CSULB Geoscience Diversity Enhancement Program (G-DEP)
PI Name: Elizabeth Ambos
Institution Name: California State University-Long Beach Foundation

9706871
Award Title: CREST: Center for Innovative Manufacturing of Advanced Materials
PI Name: Shaik Jeelani
Institution Name: Tuskegee University

0317741
Award Title: Synthesis, Manufacturing and Characterization of Structural Nanocomposites
PI Name: Shaik Jeelani
Institution Name: Tuskegee University

9805465
Award Title: Computational Center for Molecular Structure and Interactions
PI Name: Jerzy Leszczynski

Institution Name: Jackson State University

0338624
Award Title: SGER: Robust Gain Scheduled Control Design in Power Systems
PI Name: Vijay Vittal
Institution Name: Iowa State University

0216895
Award Title: Proposed Establishment of Pacific Rim Application and Grid Middleware Assembly (PRAGMA), 2002-2003 Workshop series
PI Name: Peter Arzberger
Institution Name: University of California-San Diego

0314015
Award Title: Pacific Rim Application and Grid Middleware Assembly
PI Name: Peter Arzberger
Institution Name: University of California-San Diego

0220069
Award Title: ITR: Privacy in Database-As-A-Service (DAS) Model
PI Name: Sharad Mehrotra
Institution Name: University of California-Irvine

0231120
Award Title: Process Oriented Guided Inquiry Learning
PI Name: Richard Moog
Institution Name: Franklin and Marshall College

0106773
Award Title: ROLE: Biomedical Engineering Thinking and Learning: The Challenge of Integrating Systems and Analytical Thinking
PI Name: Nancy Nersessian
Institution Name: Georgia Tech Research Corporation - GA Institute of Technology

0120727
Award Title: BIOCOMPLEXITY: Consequences of Greenhouse Warming for Biocomplexity and Biogeochemical Cycles: A Multidisciplinary Case Study Across the Paleocene-Eocene Boundary
PI Name: James Zachos
Institution Name: University of California-Santa Cruz

9308410
Award Title: Management and Operations of the Ocean Drilling Program
PI Name: Steven Bohlen
Institution Name: Joint Oceanographic Institutions Inc

0094162

Award Title: CAREER: Theory and Applications of Complex Social Networks
PI Name: Duncan Watts
Institution Name: Columbia University

Tools

0307274
Award Title: IMA New Directions Program: Visitors and Short Courses
PI Name: Douglas Arnold
Institution Name: University of Minnesota-Twin Cities

9810289
Award Title: Institute for Mathematics and its Applications
PI Name: Douglas Arnold
Institution Name: University of Minnesota-Twin Cities

0119934
Award Title: Earth Science Pipeline: Recruiting and retaining under-represented ethnic groups in Earth Sciences
PI Name: Alan Smith
Institution Name: California State University-San Bernardino Foundation

9808902
Award Title: Theoretical Studies of Membrane Proteins
PI Name: Barry Honig
Institution Name: Columbia University

0335214
Award Title: EIN: Collaborative Research: PlanetLab: An Overlay Testbed for Disruptive Network Services
PI Name: Larry Peterson
Institution Name: Princeton University

0244577
Award Title: Atacama Large Millimeter Array (ALMA)
PI Name: Riccardo Giacconi
Institution Name: Associated Universities Inc/National Radio Astronomy Observatory

0107417
Award Title: Support for Operations and Management of LIGO
PI Name: Barry Barish
Institution Name: California Institute of Technology

0096900

Award Title: The Sloan Digital Sky Survey
PI Name: Richard Kron
Institution Name: Astrophysical Research Consortium

0116067
Award Title: Collaborative Research: Magma Reservoir-Conduit Dynamics Revealed by Borehole Geophysical Observatory and Continuous GPS
PI Name: Alan Linde
Institution Name: Carnegie Institution of Washington

0116826
Award Title: COLLABORATIVE RESEARCH: Magma Reservoir-Conduit Dynamics Revealed by Borehole Geophysical Observatory and Continuous GPS
PI Name: Barry Voight
Institution Name: Pennsylvania State Univ University Park

0116485
Award Title: Collaborative research: magma reservoir-conduit dynamics as revealed by a borehole geophysical observatory and continuous GPS
PI Name: Pamela Jansma
Institution Name: University of Arkansas

9619019
Award Title: National Computational Science Alliance
PI Name: Robert Pennington
Institution Name: University of Illinois at Urbana-Champaign

9619020
Award Title: National Partnership for Advanced Computational Infrastructure
PI Name: Francine Berman
Institution Name: University of California-San Diego

0085206
Award Title: Terascale Computing System
PI Name: Michael Levine
Institution Name: MPC Corporation

0307136
Award Title: Terascale Computing System
PI Name: Michael Levine
Institution Name: MPC Corporation

0122449
Award Title: ITR/IM: Building the Framework of the National Virtual Observatory
PI Name: Alexander Szalay
Institution Name: Johns Hopkins University

0121293
Award Title: ITR/SI: Real-Time Long-Distance Terascale Computation for Full Bandwidth Tele-Immersion
PI Name: Henry Fuchs
Institution Name: University of North Carolina at Chapel Hill

0332116
Award Title: The TeraGrid Proposal: Cyberinfrastructure for 21st Century Science and Engineering
PI Name: Robert Pennington
Institution Name: University of Illinois at Urbana-Champaign

0122272
Award Title: The TeraGrid: Cyberinfrastructure for 21st Century Science and Engineering
PI Name: Francine Berman
Institution Name: University of California-San Diego

9730202
Award Title: EuroLink: High Performance International Internet Services between Research and Education Institutions in the United States and Europe/Israel
PI Name: Thomas DeFanti
Institution Name: University of Illinois at Chicago

9730201
Award Title: TransPAC: A High Performance Network Connection for Researchand Education Between the vBNS and the Asia-Pacific AdvancedNetwork (APAN)
PI Name: Michael McRobbie
Institution Name: Indiana University

0225379
Award Title: Integrated Sensing: Energy-Aware Articulation in Sensor Networks
PI Name: William Kaiser
Institution Name: University of California-Los Angeles

0228419
Award Title: Stochastic Network Interdiction Models for Homeland Security
PI Name: David Morton
Institution Name: University of Texas at Austin

0211396
Award Title: Computer and Database Management Assistance for REC/EHR
PI Name: Paul Arnest
Institution Name: Compuware Corporation

0116567
Award Title: MRI: Development of a Surface Scattering System for Real-time X-ray Studies of Growth and Processing
PI Name: Karl Ludwig

Institution Name: Boston University

0136671

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

0120778

Award Title: Center for Embedded Networked Sensing (CENS)

PI Name: Deborah Estrin

Institution Name: University of California-Los Angeles

APPENDIX II

LETTER FROM ADVISORY COMMITTEE FOR BUSINESS AND OPERATIONS

AND

NSF SELF-ASSESSMENT OF ORGANIZATIONAL EXCELLENCE OUTCOME GOAL

National Science Foundation
Advisory Committee For Business and Operations

June 17, 2004

Mr. Thomas N. Cooley
Director, Office of Budget, Finance,
and Award Management

Mr. Anthony A. Arnolie
Director, Office of Information
and Resource Management

Dear Mr. Cooley and Mr. Arnolie:

The Advisory Committee for Business and Operations met via teleconference on June 15, 2004 to review the Assessment of Organizational Excellence for FY 2004. Based on its discussion, the committee offers the following thoughts and observations to the Foundation. By copy of this letter, we are also sharing this information with the Advisory Committee for GPRA Performance Assessment (AC/GPA), for use in its assessment of NSF's Strategic Goals.

The committee recognizes the importance of the assessment activity NSF has undertaken for Organizational Excellence (OE). With the inclusion of OE in the NSF Strategic Plan for FY 2003-2008, it is vital that progress be assessed for this goal just as it is for NSF's previously established goals of People, Ideas, and Tools.

The committee reviewed three of the four indicators used to determine significant achievement in OE:

- Human Capital,
- Technology-Enabled Business Processes, and
- Performance Assessment.

The committee understands that the fourth OE indicator, Merit Review, will be assessed separately by the AC/GPA.

Based on its review of the information provided by NSF staff, the committee supports NSF's determination that the agency has demonstrated significant achievement for each of the three indicators. Overall, the committee concurs that the assessment is positive and reflects well on the agency.

From this initial assessment process, the committee can see the necessary elements for a more robust balanced scorecard of OE at NSF. This will require further refinement and analysis, and the committee encourages NSF to work toward this end. With that in mind, the committee encourages NSF to consider a few suggestions for future changes to approach and methodology:

- The committee suggests revising the criterion for success of the overall Strategic Outcome Goal from “at least three out of four” of the performance indicators to requiring significant achievement in all four of the indicators. The significance of each indicator warrants that NSF succeeds in all of them to show success in Organizational Excellence.

- The committee suggests that future documents for committee review follow a format along the following lines:
    - Define current areas of success, particularly those that demonstrate continued success;
    - Define areas that require improvement where some success has been demonstrated; and
    - Define areas that require improvement where success has not been demonstrated and state the future planned actions in these areas.

- Currently, many of the achievements noted for the elements speak more to processes or indicators of success, not specifically of an actual accomplishment. While the committee recognizes that confirmation from external entities and mention of process is important and necessary for validation, it is also important to clarify the achievements. The committee suggests that NSF revise the format to focus on identifying these achievements.

- The committee suggests that the elements of assessment need more baseline context to provide perspective of where NSF is on the spectrum of change — where they are and where they plan to go. Where ever the objective is quantified, which should be in most instances, the statement of achievement should provide the original annual objective in quantified terms, and compare that to the achievement using the metrics that demonstrate the extent of achievement. Significant shortfalls and over achievements should be briefly explained.

- The committee also suggests minor revisions to the current document be made prior to the AC/GPA meeting for their use.

We hope that NSF and the AC/GPA find this information useful. The committee welcomes the opportunity to participate in future assessment activities for OE.

On behalf of the committee,

Tom Dausch
Chair, June 15, 2004 Teleconference

cc: Dr. Norine Noonan, Chair, AC/GPA

National Science Foundation
Assessment of Organizational Excellence
June 2004

NSF Assessment: Organizational Excellence

Introduction and Context

With the addition of Organizational Excellence (OE) to the NSF Strategic Plan for FY 2003-2008, NSF this year for the first time will assess whether it has demonstrated significant achievement toward this goal. The framework for this assessment was presented at the March 31, 2004 meeting of the Advisory Committee for Business and Operations (AC/B&O).

NSF is seeking input from the AC/B&O for three of the four indicators used to determine significant achievement in OE:

- Human Capital,
- Technology-Enabled Business Processes, and
- Performance Assessment.

(The fourth OE indicator, Merit Review, will be assessed by the Advisory Committee for GPRA Performance Assessment.)

NSF's assessment of its performance toward the three aforementioned OE indicators is presented in the attached document. In reviewing the document, NSF encourages the AC/B&O to focus on two central questions:

1. Does the evidence presented support a determination that NSF has demonstrated significant achievement for the indicator?

2. Should any changes in approach or methodology be considered for future OE assessments?

The AC/B&O's findings and conclusions will be presented to the AC/GPA for use in developing its report concerning NSF performance with respect to the indicators associated with each of NSF's four strategic outcome goal: People, Ideas, Tools, and OE. The recommendations developed by the AC/GPA are used, along with other qualitative information and quantitative management results, to prepare NSF's Performance and Accountability Report.

The Organizational Excellence Goal

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

Excellence in managing NSF's activities is an objective on par with the Foundation's mission-oriented outcome goals. NSF's performance in the Organizational Excellence Strategic Outcome Goal is successful, for GPRA purposes, when significant achievement is demonstrated for the majority (at least three out of four) of the following performance indicators:

- **Merit Review: Operate a credible, efficient merit review system.** NSF's merit review process is the keystone for award selection, through which NSF achieves its goals. All proposals for research and education projects are evaluated using two criteria: the intellectual merit of the proposed activity and its broader impacts. Specifically addressed in these criteria are the creativity and originality of the idea, the development of human resources, and the potential impact on the research and education infrastructure. Ensuring a credible, efficient system requires constant attention and openness to change.

- **Human Capital Management: Develop a diverse, capable, motivated staff that operates with efficiency and integrity.** NSF is dependent on the capability and integrity of its staff. Innovative methods of recruitment, development, retention and employee recognition are needed to meet future challenges.

- **Technology-Enabled Business Processes: Utilize and sustain broad access to new and emerging technologies for business application.** NSF has moved aggressively to adopt new technologies in our business processes. NSF must sustain and further develop exemplary mechanisms to streamline business interactions, enhance organizational productivity, ensure accessibility to a broadened group of participants, and maintain financial integrity and internal controls.

- **Performance Assessment Develop and use performance assessment tools and measures to provide an environment of continuous improvement in NSF's intellectual investments as well as its management effectiveness.** An organization that is dependent on public funds must be accountable to the public. The development and use of effective indicators of agency performance -- measuring NSF's ability to meet mission-oriented goals, its competent use of resources in the investment process, and its efficiency and effectiveness as a reliable partner to others -- are needed to better explain the agency's role to the public.

Human Capital Management:
Develop a diverse, capable, motivated staff that operates with efficiency and integrity.

Strategic Focus	Elements of Assessment (detailed discussion attached)
Diverse	Diversity Initiatives Diversity Statistics
Capable	NSF Academy: Government-wide eTraining Initiative
Motivated	Performance Management System Improvements Employee Recognition Innovative Human Capital Studies within NSF
Overall Human Capital Strategy	Innovative Human Capital Studies within NSF Development and Implementation of Human Capital Management Plan eGovernment HR Initiatives

Technology Enabled Business Processes:
Utilize and sustain broad access to new and emerging technologies for business applications.

Strategic Focus	Elements of Assessment (detailed discussion attached)
Continued Leadership and Innovation in eGovernment	President's Quality Award for Management Excellence Government-Wide Grants Management Initiatives PMA Scorecard: eGovernment green
Enabling Human Capital	ePayroll Initiative
World Class Secure Infrastructure	FY 2003 Federal Information Security Management Act (FISMA) Compliance "A-" on House Government Reform IT Security Scorecard Greater IT Security Awareness Throughout Foundation

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

Strategic Focus	Elements of Assessment (detailed discussion attached)
Development and Use of Effective Indicators of Agency Performance	High-level performance management process Development of Measures for GPRA PART Activities
Competent Use of Resources in the Investment Process	R&D Investment Criteria Committees of Visitors President's Management Agenda
Measuring NSF's Ability to Meet Mission-Oriented Goals	Advisory Committee for GPRA Performance Assessment

Human Capital Management

FY 2004 Assessment Methods and Results: Organizational Excellence Goal	
Human Capital Management Objective: *Develop a diverse, capable, motivated staff that operates with efficiency and integrity.* NSF has demonstrated significant achievement in developing a diverse, capable, motivated staff that operates with efficiency and integrity.	
Element	Achievement
Diversity Initiatives	During the last year, NSF significantly revised its recruitment fair display and expanded its recruitment materials to "get individuals to the table" so that the agency can sell itself as an employer of choice. At the same time, we have significantly expanded our participation in job fairs and in professional association meetings by having attended or being scheduled to attend more than 14 events during this fiscal year, including: Society for Advancement of Chicano and Native Americans in Science (SACNAS) Conference; American Indian Science and Engineering Society (AISES) Annual Conference; U.S. Department of Labor Perspectives of Employment of Persons with Disabilities Conference; Society of Hispanic Professional Engineers (SHPE) Conference; and National Society of Black Engineers (NSBE) Conference. Recruiting at each of the 14 events was a new venture for NSF in FY2004, having not actively participated in such conferences last fiscal year. In pursuing its diversity initiatives, the Division of Human Resource Management (HRM) and NSF Directorates and Offices have partnered with the SACNAS, SHPE, and NSBE to provide both science and engineering-specific information to potential candidates, as well as information concerning the benefits of employment with the Federal Government. HRM also plays an extremely active role on NSF's Diversity Committee working with Directorate representatives to promote the availability of special appointing authorities and to focus more attention on the special emphasis programs, such as Outstanding Scholar, Programs for Persons with Disabilities, Disabled Veterans Programs, NSF's own Scholarship for Service Program, and the Student Educational Employment Program. Diversity Committee members have shared information on these programs with their Directorate staffs and more active involvement in such programs will be recommended in the Diversity Plan, which is discussed below. In addition to partnering with NSF Directorates and Offices, NSF has recently begun a dialogue with AISES in an effort to develop a summer internship program, which will allow NSF to provide work and learning opportunities for Native American college students during the summer months. For this summer, the program is being run under the auspices of our Hispanic Association of Colleges and Universities (HACU) Internship Program and will be assessed at the end of the summer to determine its success. Two Native American students were selected this year for participation in the summer internship program where they will work with mentors to achieve specific goals outlined in a work plan. (continued)

Diversity Initiatives (continued)	NSF has also begun to work closely with the Department of Labor, Office of Disability Employment Policy and plans to participate in its upcoming Disability Mentoring Day scheduled for Wednesday, October 20, 2004. NSF will designate one or more management officials who will agree to have disabled individuals shadow them for a day to obtain valuable insight into management perspectives. Most recently, NSF has become a member of the Partnership for Public Service. Participation in the quarterly meetings has provided a forum for HRM to meet with representatives from other Federal agencies and share information and experiences that are considered promising practices for implementation. Many of these discussions have focused on useful strategies and challenges for targeting and attracting talented applicants from underrepresented groups. NSF has an affirmative responsibility in its mission and strategic objectives to seek out and fund opportunities to increase minority and female interest in our continuing commitment to science and engineering research and education. NSF also funds numerous student programs that allow selectees to solidify their interest in science and engineering at colleges and universities, at science and technology centers, through other NSF-funded institutions, or with the Federal Government. While NSF has made significant progress on diversity, it continues to place overarching emphasis on improving its posture as an employer of choice for minorities and women, specifically in science, technology, engineering and mathematics fields. In that regard, during this fiscal year, NSF drafted a diversity plan framework that is currently being fleshed out into a formal document that will guide the Foundation's efforts over the next 1-3 years. The plan will take a comprehensive look at how to improve NSF's opportunities to reach out to and recruit from minority and female communities. Additionally NSF will comprehensively assess NSF's workplace environment and career development opportunities to proactively implement programs related to retention and development of staff. Additional evidence of NSF's commitment to a diverse workforce rests in its employment during the current fiscal year of three new employees with a focus on diversity issues. Within the Office of the Director, NSF created a position of Senior Advisor for Science and Engineering (S&E) Workforce. The incumbent will oversee all of NSF's efforts to broaden participation in S&E careers and will serve as NSF's principal liaison to minority-serving institutions. Within HRM, NSF hired a marketing and outreach specialist in both its Staffing and Classification Branch and its Executive and Visiting Personnel Branch. These individuals have already had a significant impact on NSF's diversity endeavors, developing the outreach plan that resulted in NSF's participation in the career fairs noted above, and developing a draft outreach plan for rotators that will result in more direct involvement with Directorates in recruitment initiatives and that will further professionalize our marketing and outreach materials.

Element	Achievement
Diversity Initiatives Statistics	NSF increased its overall minority representation in the S&E category since May 2003 by 11 and increased our overall minority representation in the BO category by 15. In comparing the representation of non-minority males to the Civilian Labor Force (CLF), black males are above parity representing 20.7 percent of the BO workforce compared to a CLF of 8.7 percent. Hispanic males are above parity representing 2.0 percent of the NSF BO workforce compared to a CLF of 1.4 percent. Asian American/Pacific Islander (AA/PI) males represent 4 percent of the NSF workforce compared to 1.4 percent of the CLF. NSF is also above parity in BO for females. Non-minority females represent 49 percent of the NSF BO workforce compared to a CLF of 35.1 percent. Black females represent 46 percent of the NSF BO workforce compared to a CLF of 15.5 percent. Hispanic females are slightly below parity at 1.43 percent of the NSF BO workforce compared to 1.8 percent CLF. AA/PI females represent 4.02 percent of the NSF BO workforce compared to 2 percent CLF. In addition to NSF's exceptional standing on minority and female workforce in both Science and Engineering and in Business Operations, during the past fiscal year NSF has also hired a number of minorities and females into SES or SES-equivalent IPA positions. Of the 16 such positions that were filled in the current fiscal year or for which effective dates are currently pending, NSF hired four minorities and seven women. A significant cause of NSF's success in such hires is the total commitment the Foundation has to seeking out highly qualified minority and female candidates for senior leadership positions. Recruitment plans for senior positions must be submitted to the Deputy Director, NSF for review prior to SES/SES equivalent positions being announced. These plans must clearly state the efforts that will be undertaken to reach underrepresented communities and active steps must be taken to solicit interest. In addition, the Office of the Director and each Directorate often convene search committees to seek out potential candidates for senior positions from among broad-based interest groups.

Human Capital Management

Element	Achievement
NSF Academy: Government-wide eTraining Initiative	NSF actively supports the President's Management Agenda initiative for eTraining, an initiative that promotes development of the workforce through simplified, one-stop access to high quality eTraining products and services. o In January 2004, NSF transitioned to GoLearn, the government-wide web-based e-learning system. More than 2,000 courses are now available to staff electronically for developmental purposes, including courseware in Executive Development, Management, Communication, Customer Service, Project Management, Information Technology, and Administrative functions. Access is also available to *eBooks* which provides electronic reference materials supporting the courseware, *a Resource Center* which provides access to libraries around the world, an *eMentoring* service that allows online interaction with experienced, certified mentors operating within a virtual classroom and a *Competency Management Center* that provides employees, supervisors and managers with the tools necessary to help manage career development and assist in strategic development of human capital. o Collaborative efforts are underway with OPM to acquire a Learning Management System (LMS), the key software and system necessary to manage and provide learning, performance support and career development opportunities for staff, and facilitate succession planning. The LMS will be consistent with and support the Human Capital Management Plan and recommendations stemming from the Business Analysis. A Memorandum of Understanding with OPM will be signed shortly. Once signed, the process of acquiring and implementing the LMS will commence, a process that is expected to take 18 months to complete.

Human Capital Management

Element	Achievement
Performance Management System Improvements	For the current appraisal period that began April 1, 2004, NSF is linking performance management plans for all employees to the NSF mission, strategic goals, and/or objectives. The purpose of this linkage is to ensure that all performance requirements are directly tied to mission accomplishment and that employees maintain a clear line of sight between what they do and how it helps NSF achieve its objectives.
Employee Recognition	NSF has a long history of recognizing employee achievement. In recent years, the Deputy Director, NSF, has incrementally increased the monies available to recognize annual performance that, for this appraisal period, equated to 5 percent of General Workforce salaries. The performance bonus program allows directorates to determine formulas that they believe most appropriately recognize performance and contributions. Such flexibility allows directorates to tailor the program to best meet their needs. The performance bonus process is appreciated by employees and contributes to the overall view of NSF as an employer of choice. In addition, NSF holds an annual Director's Award ceremony that publicly recognizes individuals for specific, valuable contributions to the mission of the agency. Selection as a Director's Award recipient is highly prized and valued by employees. In the first-ever organizational survey assessment across the Federal Government, National Science Foundation ranked second out of 28 Federal agencies as a "Best Place to Work." The analysis was a joint endeavor between two independent, non-profit organizations - Partnership for Public Service and Institute for the Study of Public Policy Implementation. This accomplishment has been widely recognized throughout the Federal community and has been featured in the national press.

Human Capital Management

Element	Achievement
Innovative Studies on Human Capital Within NSF	NSF has implemented two comprehensive studies of human capital issues within the Foundation. The first study is the eJacket Human Capital Pilot Study. This study was initiated to recognize and begin to anticipate and address the way change (in this case, technological) impacts agency staff. The study concentrates on how effectively change is communicated, the impact on workload that results from change, as well as the impact on competencies, performance expectations and morale. Results from this study will be used to inform how NSF can better address the human capital impacts of change in the future. In addition, NSF is implementing an Administrative Functions Study to determine how best to organize administrative positions in research organizations to reduce administrative burden on science and engineering positions and to provide enhanced learning opportunities for administrative staff. The study will develop recommendations for senior management consideration on the future of such positions in the agency. The concept and scope of both of these studies has received praise from the Office of Personnel Management, which is closely reviewing methodology and eventual results to use as possible best practices for other agencies.
Development and Implementation of Human Capital Management Plan	To ensure that the human capital needs of the agency were determined and addressed, NSF used a broad-based approach to develop its Human Capital Management Plan. Representatives from a variety of job families in all of NSF's directorates and offices participated in identifying where the agency should focus its human capital initiatives in the next few years. This approach assures that the "real" issues and concerns that impact the diversity, capabilities, performance and motivation of the staff are fully addressed. The content of the plan is continuously assessed and adjustments are made to assure it reflects the "current" human capital needs of the organization. In addition to developing a broad-based Human Capital Management Plan which outlines goals and action items that will be accomplished within the next 3-5 years, NSF has implemented a baseline competency model for all of its positions and has begun to use competencies in its recruitment, learning and performance management endeavors. NSF has conducted a comprehensive workload analysis, the results of which can be used to assess the human capital implications of future business process scenarios. The agency has created an HR accountability system and has begun tracking and sharing HR metrics with its Directorates and Offices.

Human Capital Management

Element	Achievement
eGovernment HR Initiatives	NSF is actively involved in all current eGovernment HR initiatives headed by the Office of Personnel Management. Foremost among these is the transfer of its payroll and personnel to the Department of the Interior (DOI) in May 2004, as a result of a major government-wide initiative to standardize, consolidate, and integrate government-wide federal civilian payroll services and procedures. NSF is also currently implementing the eClearance initiative that will automate the process for completion of background investigation forms. NSF has implemented Recruitment One Stop establishing a direct link between its automated staffing system and OPM's USAJOBS. NSF is serving as one of 19 partner agencies on the Human Resource Line Of Business Task Force chaired by OPM, which has been tasked with transforming the current Federal Human Resource Information System environment into one that is modern, cost-effective, standardized and integrated with other management information systems and e-Gov initiatives across the entire Federal Government. The task force has established a phased approach that will ultimately achieve the end state of certified, modernized and integrated Federal HRIS. Through the introduction of its eRecruit system, NSF has lowered the amount of time it takes from receipt of request to announce to selection from 148 days (103 median) to 80 days (55 median).

Technology Enabled Business Processes

FY 2004 Assessment Methods and Results: Organizational Excellence Goal

Technology Enabled Business Processes
Objective: *Utilize and sustain broad access to new and emerging technologies for business applications.*

A supporting objective for the Organizational Excellence Goal is to: **Utilize and sustain broad access to new and emerging technologies for business application.** NSF has moved aggressively to adopt new technologies in our business processes. NSF must sustain and further develop exemplary mechanisms to streamline business interactions, enhance organizational productivity, ensure accessibility to a broadened group of participants, and maintain financial integrity and internal controls.
(Source: Strategic Plan FY 2003 – FY 2008, Sept. 30, 2003)

NSF has demonstrated significant achievement in the use of new and emerging technologies for business applications. Highlights of significant achievement are focused in two areas: eGovernment and IT Security. External entities such as OMB, House Government Reform Committee and others have recognized NSF's many important and visible accomplishments.

Element	Achievement
President's Quality Award for Management Excellence	NSF was singled out for outstanding performance and results in the area of "Expanded Electronic Government." In December 2003, the National Science Foundation received the President's Quality Award for Management Excellence for the Foundation's innovative electronic capabilities to solicit, receive, review, select, award, manage and report results on public research and education investments. The award recognizes NSF's successful FastLane system, an interactive, real-time, web-based system used by over 200,000 scientists, educators, technology experts and administrators, to conduct NSF business over the Internet. In fiscal year 2003, more than 40,000 proposals (more than 99.9 percent of all proposals submitted to NSF), 190,000 peer-reviews, 25,000 progress reports, 15,000 cash requests, 10,000 post-award notifications and requests and 7,500 graduate research fellowship applications were submitted and processed using FastLane.

Technology Enabled Business Processes

Element	Achievement
Government-Wide Grants Management Initiatives	NSF is a Grants.gov partner. NSF has fully demonstrated its support for Grants.gov by providing financial and human resources; participating in all of the working groups responsible for planning and implementing Grants.gov; and leveraging NSF's experience in electronic research administration. Grants.gov has made significant progress toward providing the grants community with one place to find and apply for grants. The "Find" feature was launched in February 2003 and NSF was among the first agencies to begin posting their funding opportunities. NSF plans to integrate with the Grant.gov "Apply" feature in FY 2004-FY2005. As part of this effort, NSF, along with the National Institutes of Health, the Department of Energy, and others, have defined a set of standard data elements and associated forms for Research and Related grants that are expected to be supported by Grants.gov. The development and delivery of this data set to Grants.Gov is an important accomplishment, as it will result in more consistent grant application information requirements that the research community and applicants must meet. Adoption of a government-wide standard research application will improve the quality and consistency of the information that will be part of the common "Apply" function. In March 2004, the Office of Management and Budget (OMB) formed a Grants Management Line of Business task force as part of its government-wide business consolidation efforts. The National Science Foundation and the Department of Education were invited to be co-managing partners of this task force. The vision of the task force is to implement a government-wide framework to effectively support end-to-end grants management activities that: promote citizen access, customer service, financial and technical stewardship; achieve agency missions; and ensure business efficiencies and economies of scale within varying business model's identified market segments. NSF and the Department of Education, working with other Federal grants-making agency partners, will develop a business case for submission in the FY06 budget process, to implement a common solution and target architecture that will fulfill the task force vision.

Technology Enabled Business Processes

Element	Achievement
ePayroll Initiative	The National Science Foundation transferred its payroll and personnel to the Department of the Interior (DOI) in May 2004. This is a major government-wide initiative to standardize, consolidate, and integrate government-wide federal civilian payroll services and procedures with the goal of consolidating twenty-two federal payroll systems into four. As a result of this initiative, NSF can better integrate payroll, human resources, and financial functions and will avoid the cost of maintaining agency-unique payroll and personnel processing applications.
eGovernment Green on the President's Management Agenda Scorecard	NSF continues its leadership role in the Federal eGovernment initiatives that are directly relevant to NSF's science and engineering research and education mission as well as the supporting initiatives that affect all Federal entities. NSF is a partner on Grants.gov and plays a significant role in development of eGovernment initiatives. In light of its contributions to eGov, at both the NSF-level and the government-wide level, NSF has maintained a green status on the President's Management Agenda (PMA) scorecard for electronic government since FY 2002. (Source E-Gov Act Report of Dec 15, 2003)

Technology Enabled Business Processes

Element	Achievement
FY 2003 Federal Information Security Management Act (FISMA) Compliance	Protecting NSF's information resources remains a top management priority. NSF has established a strong and comprehensive security program that is consistent with government-wide guidance and patterned after industry best practices. The success of NSF's IT Security Program is reflected by the Office of Management and Budget's (OMB) acceptance of the annual NSF Executive Summary of the FY2003 Federal Information Security Management Act (FISMA) Report. NSF is required to assess its security posture annually in key areas. Specific areas include an inventory of major applications and general support systems and ensuring they are certified and accredited. Eighteen of nineteen major applications and general support systems were certified and accredited in FY 2003. Certification and accreditation is a key metric for OMB and linked to future funding of IT and security investments. All major applications and general support systems have security integrated into their lifecycle, are assessed for level of risk, and have security plans and contingency plans that are tested during disaster recovery and continuity of operations exercises. NSF also maintains a strong plan of action and milestone process to track security weaknesses. As part of its FISMA review, the Office of Inspector General (OIG) made three recommendations in the following areas: certification and accreditation; the United States Antarctic Program (USAP) security program; and security policies and procedures. NSF concurred with the OIG recommendations. Through our strong and comprehensive security program, NSF proactively responded to the recommendations. New policies and procedures have been issued, major applications and general support systems are scheduled for certification and accreditation in a three-year cycle and USAP has strengthened its security program. Security tasks and objectives are closely and aggressively tracked and monitored to meet target dates as NSF continues to assess and evaluate improvements that can be made to increase its overall security posture. NSF continues to report significant security statistics and progress on a quarterly basis as required by OMB.

Technology Enabled Business Processes

Element	Achievement
"A-" on House Government Reform IT Security Scorecard	The House Committee on Government Reform Subcommittee on Technology, Information Policy, Intergovernmental Relation and the Census recognized and commended NSF's significant progress on information security with an "A-" security scorecard grade for FY 2003. Strengths of the security program are based on an inventory of mission critical systems, strong incident identification and reporting procedures, and strong plans of action and milestones to eliminate security weaknesses. NSF continues to focus on and improve security processes in these areas to further strengthen its security posture and protect its investments. The results of the House Committee on Government Reform IT Security Scorecard may be found at http://reform.house.gov/TIPRC/Hearings/EventSingle.aspx?EventID=652.
Greater IT Security Awareness Training Throughout Foundation	FY 2003 has been a year of greater information technology (IT) security awareness throughout the Foundation, from CIO briefings at executive meetings to direct communication with users. Security is increasingly a function of business at NSF. Security awareness is facilitated through disaster recovery and continuity of operations exercises, contingency plan testing, department newsletters, meetings and seminars, security policy bulletins, virus alert emails, and the annual agency-wide FISMA security review and Security Awareness Training. In FY 2003 more than 1,700 or 96 percent of NSF staff and contractors completed IT security awareness training.

Performance Assessment

FY 2004 Assessment Methods and Results: Organizational Excellence Goal

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

An organization that is dependent on public funds must be accountable to the public. The development and use of effective indicators of agency performance -- measuring NSF's ability to meet mission-oriented goals, its competent use of resources in the investment process, and its efficiency and effectiveness as a reliable partner to others -- are needed to better demonstrate the agency's role to the public.

NSF has demonstrated significant achievement in performance assessment as shown through the development and use of qualitative (e.g. external expert evaluation) and quantitative (e.g. OMB's Program Assessment Rating Tool) evaluations.

I. Overview

Performance assessments at NSF support strategically oriented investments to achieve long-term outcomes (Figure 1). Performance measures related to organizational effectiveness assist in measuring the internal performance and processes that support the NSF Mission. Historically, NSF has assessed the long-term outcomes from basic research and education through expert evaluations. The Department of Energy has suggested a different approach for basic research evaluation by setting dates for making future major discoveries and setting milestones for reaching these discoveries. However, the broad range of science and engineering covered by NSF, the critical and extensive use of merit review for selecting new awards, and the flexibility to respond to changing needs for expanding the frontier of science and engineering lends itself instead to external evaluation by experts and leaders in academia, industry and government to determine progress toward our long-term goals of People, Ideas, Tools and Organizational Excellence. This section discusses the various types of internal and external assessment tools used to measure NSF's performance.

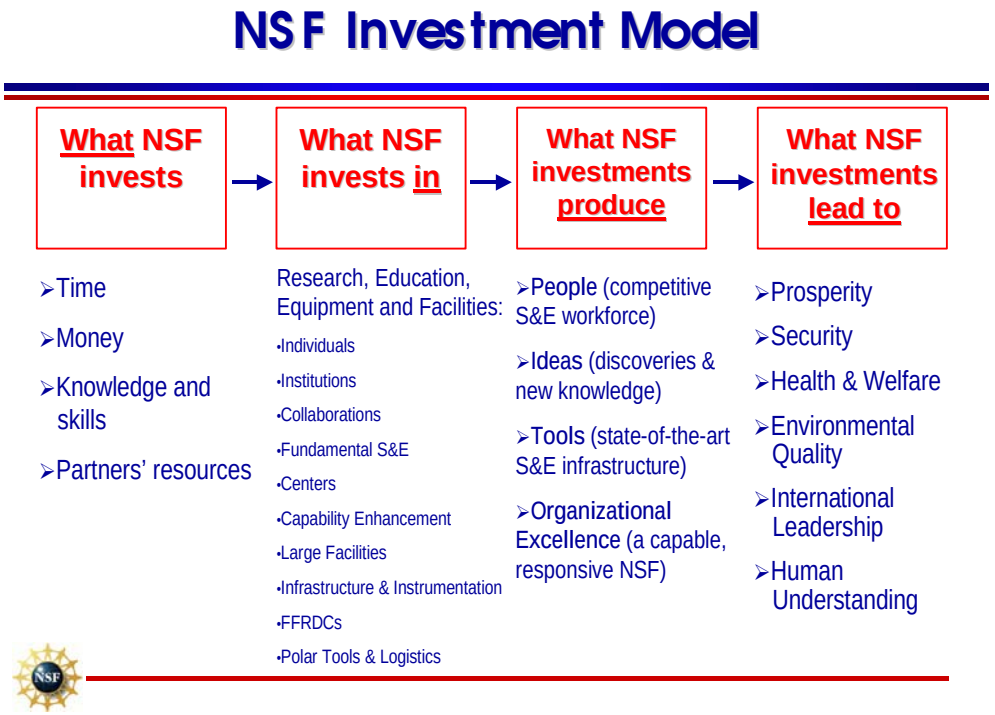
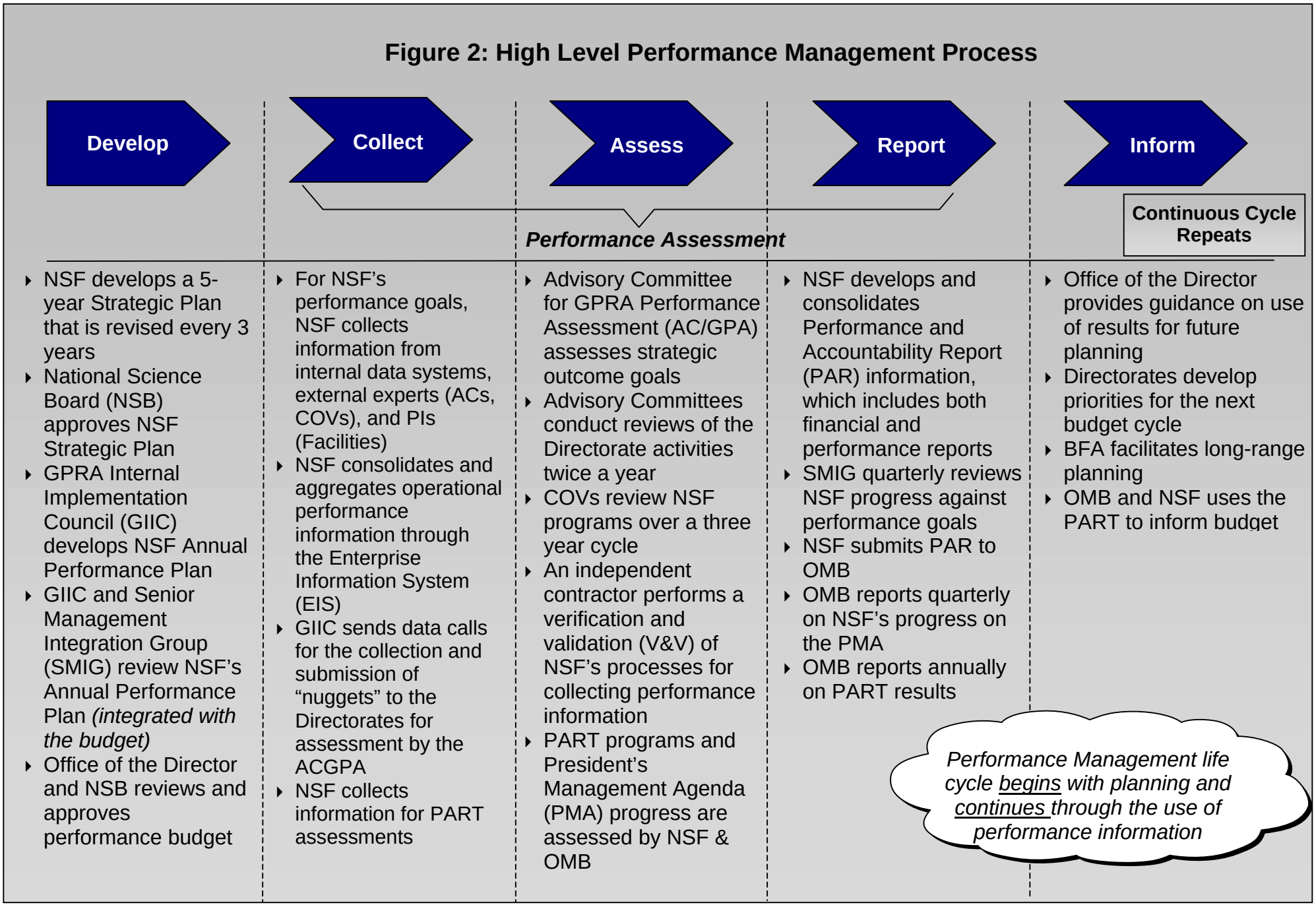


Figure 1: NSF Investment Model (NSF Strategic Plan FY 2003-2008)

II. Development and Use of Effective Indicators of Agency Performance

Figure 2: High Level Performance Management Process



The performance management cycle at NSF covers stages that include development, collection, assessment, reporting and use of evaluations (see Figure 2). NSF reports annually on its performance in the Foundation's Performance and Accountability Report (PAR; Figure 3). The latest report, dated November 17, 2003 and available at http://www.nsf.gov/pubs/2004/nsf0410/, details the Foundation's performance against strategic and management goals. Chapter 2 of the PAR provides over 120 pages of detailed performance results. In addition to the PAR, a summary of the performance results appears in the Performance Highlights Brochure from January 2004 (www.nsf.gov/pubs/2004/nsf04011/).

Government Performance and Results Act (GPRA)

NSF uses a combination of qualitative goals, evaluated with the assistance of external experts, and quantitative goals, determined primarily through NSF's Enterprise Information System, when evaluating performance under the Government Performance and Results Act (GPRA). Annual goals were divided into strategic goals and management goals, consistent with the old Strategic Plan (from FY 2000). Yearly results for these two categories are shown in Table 1.

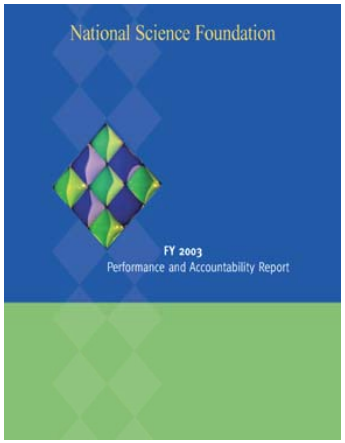


Figure 3: Performance and Accountability Report

Annual Goal Type	FY99	FY00	FY01	FY02	FY03
Strategic Outcome Goals	100%	75%	80%	100%	100%
	5 of 5	*6 of 8*	*4 of 5*	*4 of 4*	*4 of 4*
Management Goals	67%	60%	61%	74%	63%
	15 of 20	*18 of 28*	*15 of 23*	*18 of 23*	*10 of 16*

Table 1: Annual goal success rate from FY 1999 – 2003

For FY 2003 we met all of our strategic outcome goals and 10 out of 16 management goals. IBM Business Consulting Services, an independent contractor, verified and validated the performance information and data.

Strategic Outcome Goals: We were successful for the four annual outcome performance goals. In addition to annual progress toward our Strategic outcome goals of People, Ideas and Tools, for FY 2003 there was another goal for the Math Science Partnerships program. At the June 2003 AC/GPA meeting, the AC/GPA determined that there was "not enough information to make a judgment about significant achievement in 2003" for Math Science Partnership (MSP) awards. This was understandable as MSP awards were less than a year old at the time of the AC/GPA meeting. Before the end of FY 2003, NSF received annual reports from MSP grantees, completed an assessment, with the assistance of a third party contractor, Westat, of MSP strategic plans, and NSF analyzed the merit review results for the awarded MSP programs to obtain information on the ability of the MSP projects to achieve the goal indicators on awardee quality and infrastructure. Based upon the additional evidence available after the June 2003 AC/GPA meeting, NSF determined MSP met the goal for FY 2003. IBM Business Consulting validated that NSF "reached a reasonable conclusion that NSF achieved Goal III-IB [MSP Goal] based on the quality of the performance information and analyses of the MSP program results to date" in a chapter devoted to MSP (Chapter 9 of the FY 2003 NSF Performance Measurement Validation and Verification Report). For FY 2004, Organizational Excellence will be evaluated as a strategic outcome goal, consistent with the Strategic Plan.
Management Goals: NSF was successful for 10 of our 16 goals (63%) in this area:

Performance Assessment

- Allocate at least 85% of basic and applied research funds to projects that undergo merit review (Goal IV-1). NSF achieved 89%.
- Ensure that at least 70% of reviews with written comments address aspects of both generic review criteria (Goal IV-2). NSF achieved 90%.
- Ensure that 95% of program announcements are available at least three months prior to proposal submission deadlines (Goal IV-4). NSF achieved 99%.
- Process 70% of our proposals within six months of receipt (Goal IV-5). Seventy-seven percent of proposals to NSF were processed within six months of receipt.
- Increase our average annualized award size for research projects to $125,000 (Goal IV-6). NSF's average annualized award size was $135,609.
- Continue to advance "e-business" by receiving through FastLane and processing electronically 90 percent of Principal Investigator award transfers (Goal IV-10). Greater than ninety-nine percent of Principal Investigator award transfers were processed electronically.
- Maintain and enhance the agency-wide security program to ensure adequate protection of NSF's IT infrastructure and critical assets by having: a) 95% of major systems with approved security plans on file and b) 95% of major systems with documented certification and accreditation. (Goal IV-12). Achieved.
- Ensure that diversity considerations are embedded in activities related to agency staffing of scientists and engineers through initiating development of a NSF S&E diversity plan (Goal IV-13). Achieved.
- Align or develop competency-based curricula, through the NSF Academy, that provide cross-functional, work-based team learning opportunities through the initiation of development of new courses or revision of existing courses to address program management, leadership development, and technology and business process training (Goal IV-15). Achieved.
- Develop competency-based, occupation classification alternatives that support the agency's strategic business processes and capitalize on its technology enabled business systems through identification of workforce competencies for all current NSF job families and initiation of identification of competency-based, classification alternatives (Goal IV-16). Achieved.

We were not successful for 6 of the 16 management goals (historical trends are shown in the Performance and Accountability Report):

- Ensuring that NSF Program Officers address both generic review criteria for at least 80% of award decisions (Goal IV-3). Program Officers commented on aspects of both merit review criteria for 53% of award decisions. The underlying workload-related issues are under review as part of the NSF Business Analysis.
- Increasing the average duration of awards for research projects to at least three years (Goal IV-7). NSF's average duration was 2.9 years. Sufficient resources were not available to achieve both the average annualized award size and the average duration goals. The award size goal was the greater focus in FY 2003. Success rates, however, continue to drop.
- For 90 percent of construction, acquisition and upgrade projects, keeping any negative cost and schedule variances to less than 10 percent of the approved project plan (Goal IV-8). Eighty-eight percent of projects kept negative cost and schedule variances to less than 10 percent of the approved project plan. NSF is continuing to strengthen facilities project management issues.
- For 90 percent of operational facilities, keep scheduled operating time lost to less than 10 percent (Goal IV-9). Eighty-seven percent of facilities kept scheduled operating time lost to less than 10 percent. NSF is continuing to strengthen facilities project management issues.
- Continuing to advance "e-business" by implementing Phase III of the Electronic Jacket application by implementation of the electronic capability for assigning proposal processing tasks, forwarding proposals to other programs as necessary, and delegating proposal action authority (Goal IV-11). Phase III was available for NSF staff use in November 2003, two months after the end of the fiscal year.

- Showing an increase over FY 2000 in the total number of appointments to NSF science and engineering positions from underrepresented groups (Goal IV-14). NSF increased the number of appointments of women, 48 vs. 46, but the number of minorities, 25, appointed in FY 2003 was the same as FY 2000. NSF is completing work on a staff diversity plan in FY 2004.

Program Assessment Rating Tool (PART)

The Office of Management and Budget (OMB) is using an assessment tool, known as the Program Assessment Rating Tool or PART, to evaluate program performance. PART evaluates program performance in the areas of program purpose and design, strategic planning, program management and results. NSF developed the PART evaluation schedule shown in Table 2 consistent with the investment categories and priority areas in the Strategic Plan.

Results from the OMB evaluations for the FY 2005 NSF PART programs are available at http://www.whitehouse.gov/omb/budget/fy2005/pma/nsf.pdf. Only 11% of the 399 programs evaluated across government received the highest rating of "Effective." All four NSF programs that were evaluated received the highest rating.

	People	Ideas	Tools	Priority Areas
FY 2005	**Individuals**		**Facilities**	**Nanoscale S&E** **Info. Tech. Research**
FY 2006	**Institutions** **Collaborations**		**Polar**	**Biocomplexity Env.**
FY 2007		**Fundamental Science & Engineering**	**FFRDCs**	
FY 2008		**Centers** **Capability Enhancements**	**Infrastructure &** **Instrumentation**	**Workforce for 21st Century** **Mathematical Sciences** **Human and Social Dynamics**

Table 2: PART evaluation schedule. [Note that the fiscal year corresponds to the year the PART is developed for input to the budget process. Therefore, the FY 2005 PART evaluations were initially performed two years earlier, in 2003. NSF is currently working on development of the FY 2006 PART evaluations.]

III. Competent Use of Resources in the Investment Process

R&D Investment Criteria

The Office of Science and Technology Policy (OSTP) and OMB memo from May 2002 regarding FY 2004 R&D priorities (http://www.ostp.gov/html/ombguidmemo.pdf) contained a section on the R&D Investment Criteria. Consisting of Quality, Relevance and Performance, the criteria are meant to be useful in informing decision makers. They ensure that R&D managers can show the extent to which their programs justify how funds are allocated, why the investments are important and how well they are performing.

The Committee of Visitors (COV) process at NSF is an example for the Quality criterion in the OSTP/OMB memo. Of course, NSF's strong merit review system is a critical piece for ensuring quality in addition to relevance and performance. In addition to continuous program planning and performance activities, NSF has taken the following recent steps that exhibit portions of the R&D Investment Criteria:

- Submitted FY 2005 Budget Request to Congress, incorporating PART and R&D Criteria to justify the request
- Provided access to quality, relevance and performance information to the Advisory Committee for GPRA Performance Assessment for 2003 and 2004
- Initiated PART process for FY 2006 budget cycle.
- Incorporated PART and financial information into quarterly performance reports presented to senior agency management.
- Added Organizational Excellence, defined as providing an agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices, as an issue for review by external COVs
- Improved processing of proposals including reduced dwell time for FY03 and new capability for all-electronic processing of declined proposals.
- Goals and strategies in the new 2003-2008 Strategic Plan reflect the investment criteria

R&D Investment Criteria

Quality: R&D programs must justify *how* funds will be allocated to ensure quality R&D. Programs allocating funds through means other than a competitive, merit-based process must justify these exceptions and document how quality is maintained.

Relevance: R&D programs must be able to articulate *why* this investment is important, relevant, and appropriate. Programs must have well-conceived plans that identify program goals and priorities and identify linkages to national and 'customer' needs

Performance: R&D programs must have the plans and management processes in place to monitor and document *how well* this investment is performing. Program managers must define appropriate outcome measures and milestones that can be used to track progress towards goals, and assess whether funding should be enhanced or redirected.

Committees of Visitors (COV)

NSF has a long history of performing internal and external assessments. For over 25 years, COV reviews have provided NSF with external expert judgments assessing the quality and integrity of program operations and program-level technical and managerial matters pertaining to proposal decisions. COVs also provide comments on how the outputs and outcomes generated by awardees have contributed to NSF's mission and strategic outcome goals. Approximately one-third of the Foundation's programs are assessed each year through the COV process. The COV schedule is reported in Appendix 6 of the Foundation's Performance and Accountability Report while individual COV reports are now easily accessible through the Internet (http://www.nsf.gov/od/gpra/COV/start.htm).

President's Management Agenda (PMA)

The President's Management Agenda (PMA) contains five government-wide and nine agency-specific goals for improving management and results. The government-wide initiatives consist of Strategic Management of Human Capital, Competitive Sourcing, Improved Financial Management, Expanded Electronic Government and Budget Performance Integration. Agencies are rated (see Figure 4) on status and progress in each of these areas using red, yellow and green lights. The R&D Investment Criteria are also rated in the PMA although aggregated at the government-wide level. NSF has consistently scored the highest of all agencies in status for Financial Management and E-Government. Human Capital and Budget Performance Integration have also shown improvements this year in both status and progress.

IV. Measuring NSF's Ability to Meet Mission-Oriented Goals

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

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

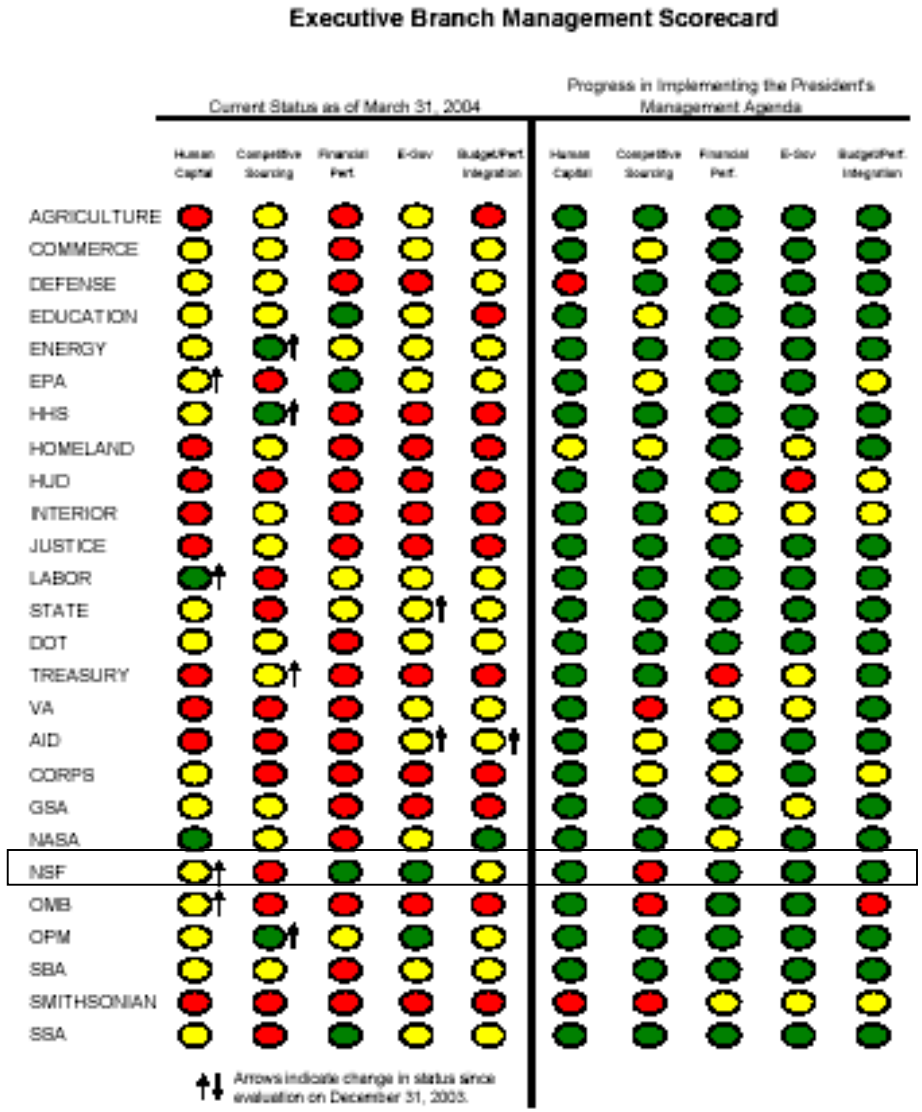


Figure 4: Executive Branch Scorecard for March 31, 2004

V. Conclusion

Based upon the range of performance assessment activities at NSF, the Foundation has demonstrated significant achievement of the Performance Assessment indicator under Organizational Excellence.