NATIONAL SCIENCE FOUNDATION

The President's Proposal:

- Underwrites cutting-edge discovery in science and engineering to provide significant breakthroughs in information technology, climate change research, mathematics, nanotechnology, and fundamental research related to combating bioterrorism;
- Concentrates more of the government's basic research under the National Science Foundation because it has the most competitive and effective research funding process in the federal government;
- Improves the quality of math and science education through the President's Math and Science Partnerships Initiative; and
- Attracts more of the most promising U.S. students into graduate level science and engineering by providing larger annual stipends.

National Science Foundation

Dr. Rita Colwell, Director

www.nsf.gov 703–292–5111

Headquarters: Arlington, VA

Number of Employees: 1,204

2002 spending: $4.6 billion

The National Science Foundation (NSF) is responsible for advancing science and engineering in the United States. NSF carries out its mission primarily by making merit-based grants to individual researchers and groups at more than 2,000 U.S. colleges, universities and other institutions. Although NSF represents about four percent of the total federal budget for research and development, it accounts for approximately one-fourth of all federal support for basic research at academic institutions. NSF evaluates research and education proposals using two criteria: the scientific merit of the proposed activity and the prospective impact on society. NSF categorizes its programs to align with its three strategic goals: 1) Ideas (research); 2) People (education); and 3) Tools (facilities and instrumentation).

Ideas

To foster discoveries in science and engineering, NSF primarily invests in researchers and educators at colleges and universities. The majority of grant recipients' work is in basic research (Ideas), which can yield important scientific discoveries that may lead to many applications. These

applications have driven economic growth and have enhanced the quality of life through advances such as better weather forecasting, earlier detection of cancerous tumors, and the creation of the Internet.

Although private industry has expanded its support for basic research over the past several years, its research focuses mostly on the short-term in order to bring new products to market. Federal investments in basic research provide a long-term foundation for breakthrough applications in areas not usually supported by private industry.

Overall Performance. NSF is the leading performer among federal agencies funding basic research. For example, of the nearly 10,000 awards NSF makes annually, 94 percent of the research awards are made through competition, based on merit review. A competitive merit review process ensures that high-quality research is funded. The accompanying table displays the percent of research competed at selected federal agencies.

NSF's competitive approach pays rich dividends. Its grants often lay the early foundation for future breakthroughs. For example, of the 11 Nobel Prize winners in the sciences in 2001, eight received NSF funding for the research that won them the award.

NSF-supported scientists are using a video camera on the back of a horseshoe crab to decipher the neural code for vision.

Agency	Percent of Research Competed in 2001
National Science Foundation	94
Department of Health and Human Services	83
National Aeronautics and Space Administration	75
Department of Commerce	42
Department of Energy	24

To further ensure high quality in its programs, external panels assess approximately one-third of NSF's programs each year, so that all programs are reviewed in a three-year period. During the past two years, these panels have judged the majority of the programs assessed to be of high quality and efficiently managed. NSF's reputation for running an efficient and effective competitive merit-review process has enabled it to provide leadership to other agencies, such as the Environmental Protection Agency and the Department of Education, in improving their research programs.

Creation of the Internet and the World Wide Web

Computers and information networks have significantly changed the way we live and how people interact with each other. NSF has been pivotal at many steps along the way. The NSF-supported NSFNET (1986–1995) has been transformed into today's Internet. Its backing of computer science research led to the creation of a graphic browser (MOSAIC) which precipitated the creation of the World Wide Web.

One of NSF's many strengths is its flexibility to redirect resources to emerging science and engineering opportunities. Unlike other agencies that own and operate numerous laboratories, NSF owns facilities related to only a few programs, such as the U.S. Antarctic Program. NSF is largely free from ongoing institutional obligations. In addition, NSF awards do not last indefinitely. The average NSF grant is typically for three years. This minimizes research stagnation or funding research that ceases to be important or cutting-edge. NSF also maintains programmatic flexibility by funding over one-half of new grants entirely in one year, rather than through installments. Instead of carrying financial commitments into future years, NSF can quickly redirect resources to new areas of emerging opportunity.

All these features contrast starkly with the increasing amount of federal research dollars directed by congressional earmarks to projects without due regard to competition or merit.

The Administration's overall aim is to position NSF to invest in priority research areas, such as information technology and nanotechnology, which connect discovery to learning, innovation, and benefit to society. Nanotechnology, which involves controlling the building of small and large structures atom by atom, holds promise for the development of technologies that could range from higher-performance materials to biomedical instruments as small as human cells.

Small Streams Contribute Far More Than Previously Thought to Cleaning Waterways

Excess nitrogen can cause ecologically damaging effects in large waterways. Small streams remove nitrogen from water faster than do their larger counterparts. This finding is based on data collected from streams in NSF's Arctic Tundra Long-Term Ecological Research site in Alaska. According to the research, the smaller the stream, the more quickly nitrogen can be removed. Taking greater care to ensure small streams can work effectively to clean the water will reduce the overall nitrogen load that makes its way into larger bodies of water. The finding could have important implications for land-use policies in watersheds from the Chesapeake Bay on the East Coast to Puget Sound in the West.

Priorities like these tend to arise from NSF's core research efforts–disciplinary and multidisciplinary programs that support ideas generated by the academic community. NSF allocates approximately 25 percent of its research budget in priority areas that will deliver scientific breakthroughs, and 75 percent in core programs to build the capacity needed for the emergence of new technologies.

Improving Performance. The President's Budget proposes to improve the quality and efficiency of federal funding of basic research at NSF by:

- *Emphasizing research in highly promising, multidisciplinary areas*. In addition to nanotechnology, the 2003 Budget provides significant NSF funding for fundamental research

related to bioterrorism, information technology, mathematics, and climate change. Each of these areas has the potential for significant breakthroughs.

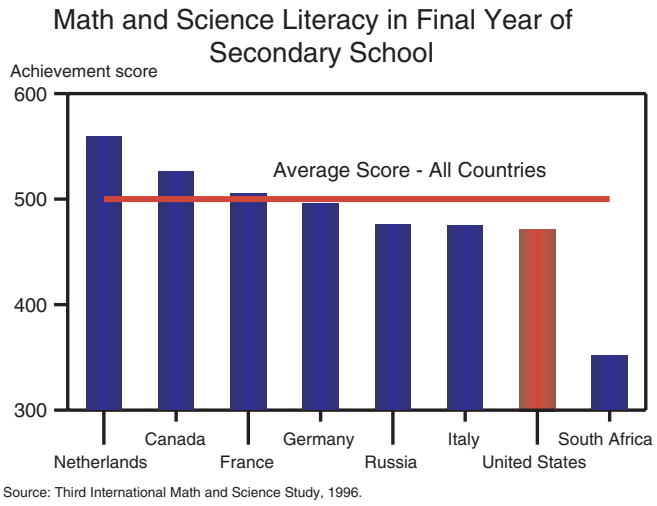
- *Improving the quality of a number of science and engineering programs by transferring them to NSF*. Based on NSF's noted expertise and success in funding competitive research, the budget transfers the National Oceanographic and Atmospheric Administration's (NOAA's) Sea Grant program and the U.S. Geological Survey's toxic substances hydrology research program to NSF to conduct merit-based competition and improve program effectiveness. The Sea Grant program will be administered in partnership with NOAA to ensure that the agency's research and outreach objectives are reflected in the program's ongoing work. The Administration may also transfer non-competitive funding from the Smithsonian Institution's astrophysics and environment programs to NSF, following a program review by an independent panel.
- *Improving efficiency of research by increasing grant size*. One means of improving research efficiency is by providing adequately-funded grants to ensure the proposed work can be accomplished as planned. Inadequately funded grants can result in an inefficient research process, with an award only funding a portion of a research project. A researcher then has to write additional proposals to get funding to complete the project and realize research objectives. The 2003 Budget increases the average annual NSF award size to $120,000, an increase of approximately $30,000 since 1998. NSF believes reaching this award size will result in approximately 200 fewer awards (a two percent reduction), from 2002. NSF also believes that the increased size will help ensure that its grants are more effective in achieving research project objectives.

People

NSF invests in People—students, researchers, and educators—to strengthen math, science, environmental, and engineering education, thus equipping the American workforce for the challenges of the 21st Century.

Overall Performance. Longtime concern persists over the state of grades K–12 science and mathematics education in the United States. The Third International Math and Science Study compared American and other countries' students in math and science and found that U.S. fourth graders did relatively well in both subjects. But by the time they reached their senior year in high school, U.S. students ranked among the worst in the world. In 2000, the National Assessment of Educational Progress showed no improvement in U.S. student performance in science and limited improvement in mathematics since 1996.

NSF-supported graduate fellows are helping teach math and science concepts to students in kindergarten through twelfth grades.



Source: Third International Math and Science Study, 1996.

Achievement in mathematics and science is most directly dependent on state and local educational systems. NSF's role is in supporting new models of math and science education. In the past decade, NSF has supported new models that, if successful, could be adopted by state and local districts, which have the resources to implement those models. Initial indications are that some of these NSF-supported models are proving successful in improving student achievement. For example, over the first six years of the NSF-funded Chicago Urban Systemic Initiative, the percentage of fourth grade students meeting Illinois state standards in science increased from 46 to 66. For the NSF-funded San Antonio Urban Systemic Initiative, the average scores of African-Americans in grade 4 on the Texas Assessment of Academic Skills increased by 32 percent over four years, and those of Hispanic students by 39 percentage points, compared to a 16 percentage point increase for Texas fourth-graders overall.

In the area of graduate education there is concern that fewer U.S. students are enrolling in U.S. graduate science and engineering programs. Since 1993, enrollment of U.S. students in graduate level science and engineering programs dropped by nine percent. During the same period, enrollment of foreign students on temporary visas increased by three percent. If fewer scientists and engineers are entering the workforce, U.S. high technology firms may have to increasingly rely on foreign high technology workers who are in the U.S. on temporary non-immigrant worker visas.

A recent survey of the Department of Education found that 57 percent of surveyed U.S. baccalaureate recipients did not apply to science and engineering graduate programs for financial reasons. Using their bachelor in science or engineering degree to get a job that may pay more than twice the level of a graduate student stipend (salary) is often more enticing to a person carrying debt from undergraduate school. One strategy of enabling U.S. students to go on to graduate school is to provide competitive stipends to ease the financial burden. NSF performance in the 1990s in providing competitive stipends was not good. From 1993 to 1999, NSF stipend levels dropped as a percentage of starting salaries for bachelor students in the sciences and engineering from 65 percent to 52 percent and the difference may be growing wider.

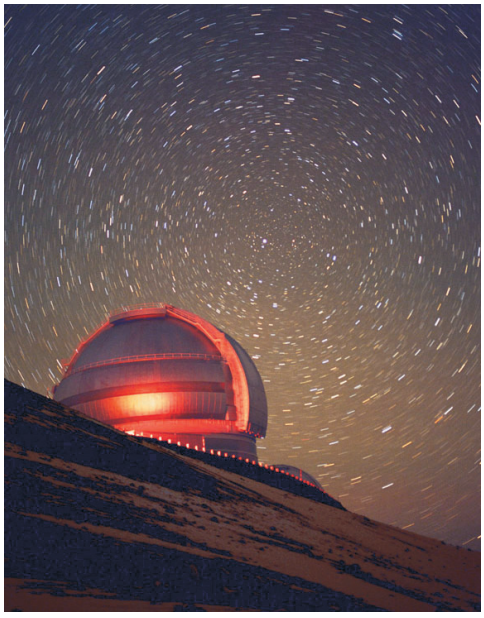
Higher Scores in West Virginia

Students in West Virginia are considered "proficient" if they score above the 50th percentile on the SAT-9. At the outset of the NSF-funded Appalachian Rural Systemic Initiative education project in 1996, schools participating in the project were scoring below the state average in both mathematics and science. By 2000, those same schools show a marked improvement in the number of students scoring in the upper percentiles. Most importantly, students in participating schools have not only "closed the gap" but all participating schools have surpassed the state average in mathematics.

Improving Performance. The President's Budget proposes to strengthen math and science education in the United States by:

- *Improving the quality of math and science education in Grades K–12 through the President's Math and Science Partnerships Initiative.* Support for the President's Math and Science Partnerships initiative is increased in the 2003 Budget. The Partnerships Initiative builds on the fact that while states and local governments deliver education, NSF has a proven record in supporting successful models to enhance math and science curriculum and student test scores as a result. The Initiative provides funds for states and local school districts to join with institutions of higher learning, particularly with their departments of mathematics, science, and engineering, to beef up math and science education.
- *Attracting the most promising U.S. students into graduate level science and engineering by providing more competitive stipends.* The 2003 Budget increases the annual stipends for NSF's fellowship and traineeship programs from $21,500 to $25,000 to further attract U.S. students to graduate level programs in science and engineering. NSF also will conduct a study on graduate stipends in 2002 to recommend what the ultimate target for graduate stipends should be as well as develop measures to assess its impact on the larger national effort to increase and improve graduate students in science and engineering.
- *Improving quality of environmental education programs.* Based on NSF's noted expertise and success in funding competitive programs, the budget transfers the Environmental Protection Agency's environmental education program to NSF to improve program effectiveness and merit-based selection.

Tools



The Gemini North Telescope on Mauna Kea in Hawaii provides some of the sharpest images of any telescope on Earth.

NSF invests in widely accessible, state-of-the-art science and engineering Tools—sophisticated instruments, equipment, facilities, databases, and large surveys. NSF's funding of facilities has grown and diversified and now includes shared-use research facilities that are often connected by high-speed networks.

Except for U.S. Antarctic Program facilities, NSF does not directly operate the large-facilities that it supports, such as the Gemini North telescope in Hawaii or the Terascale Supercomputer in Pittsburgh. NSF primarily makes awards to universities and non-profit organizations to construct, manage, and operate large projects.

Overall Performance. Research agencies must strive to keep the development and upgrade of research facilities on schedule and within budget. In running the facilities, agencies should keep the operating time lost due to unscheduled downtime to a minimum. NSF does relatively well in meeting these goals. In 2000, all 11 construction projects that NSF supports were within 10 percent of their estimated annual cost, and seven of the 11 projects were within 10 percent of meeting their annual schedule

milestones. Also in 2000, 22 of 26 operating facilities kept time lost due to unscheduled downtime to less than 10 percent of the total scheduled operating time. For major capital projects completed since 1996, cost growth on five science projects was eight percent (or $36 million), generally less than the average cost increase for major projects at most science agencies.

Although NSF has done relatively well in managing construction of its large facilities, project complexity, cost, and risk are increasing. Future projects will challenge traditional NSF approaches. To address this concern, the Administration directed NSF to develop a plan to enhance its management of large facility projects. In response, NSF is now implementing a Large Facilities Projects Management and Oversight Plan that improves the process for reviewing and approving large projects and increases oversight of its projects. All current and future large projects will be subject to these new guidelines and oversight.

Improving performance. The President's Budget proposes to improve NSF investments in Tools by:

- *Enhancing infrastructure capabilities in astronomy, earthquake research, and the environment.* The budget proposes initiating construction of the international Atacama Large Millimeter Array telescope in Chile and the Earthscope projects across the United States. The Atacama Large Millimeter Array will be the world's most sensitive, highest resolution, millimeter-wavelength telescope. This telescope will serve as a testing platform for theories of star birth and stellar evolution, galaxy formation and evolution, and the evolution of the universe itself. Earthscope will provide several instruments, some portable, to investigate the structure and evolution of the North American continent and the physical processes controlling earthquake and volcanic eruptions. This will provide significant data to assess and mitigate national risks associated with earthquakes, volcanic eruptions, and landslides. The 2003 Budget also provides funding to test at least two sites of the National Ecological Observatory Network, which will provide an integrated network of regional environmental research observatories.

The Really Sharp and The Really Fast

The Gemini Telescope Project is an international partnership that will result in two 8.1-meter telescopes (each telescope has a main mirror over 26 feet across.) One telescope, partly funded by NSF, is located on Hawaii's Mauna Kea, and the other on Chile's Cerro Pachón. Each of the Gemini telescopes is designed to provide some of the sharpest images of any telescope on (or even above) our planet. In many instances, the Gemini telescopes will outperform even the Hubble Space Telescope in clarity. Both telescopes will be fully operational in 2002.

With the capability to perform up to six trillion calculations every second, the NSF-funded Terascale Computing System in Pittsburgh will be the world's most powerful computer doing public research. In tests in 2001, the machine established itself as the second-most powerful in the world. The Terascale computer will be used for large-scale research modeling in areas that include the life sciences, weather forecasting and climate change.

- *Improving priority setting and the visibility of the selection process for large facility projects.* For the first time, the 2003 Budget identifies funding for early-stage planning and development of potential new, large facility projects. This will increase the visibility of NSF's

facility selection process. The Office of Science and Technology Policy also will request that the National Academy of Sciences review the scientific merit of IceCube and other proposed U.S. neutrino collectors in the context of current and planned neutrino research capabilities throughout the world. Neutrinos are one of the fundamental particles that make up the universe and are also one of the least understood. Understanding neutrinos better will mean greater understanding of the universe.

Research Network Brings Wireless Internet to Native American Reservations

In August 2000, the University of California, San Diego received a $2.3 million NSF award to develop a prototype wide-area network for research and education. The High Performance Research and Education Network is overcoming geographical, social and technical barriers to bring high-speed Internet access to the La Jolla and Pala Native American reservations. In remote San Diego County, the network connects the low-lying San Diego coastline with the county's mountainous eastern region, home of the reservations. This network also links the University with the Mount Laguna Observatory, an earthquake-detection site. The network is a prototype that could be useful for geophysicists, astronomers and ecologists, while demonstrating that the same tools can connect under-served educational users at remote locations like the Pala and La Jolla reservations.

Status Report on Select Programs

The Administration is reviewing programs throughout the federal government to identify strong and weak performers. The budget seeks to redirect funds from lesser performing programs to higher priority or more effective ones.

Program	Assessment	Explanation
Information Technology Research	**Effective**	Began focusing on long-term, high-risk information technology research in 2000. Priority goals and objectives identified. Five-year funding plan established. Program will be evaluated in 2002.
Nanotechnology	**Effective**	In 2001, began emphasizing long-term fundamental research aimed at discovering novel phenomena, processes, and tools at the nanoscale (10,000 times smaller than the diameter of a human hair). Priority goals and objectives identified. Five-year funding plan established. Program will be evaluated in 2003.
Core Research	**Effective**	Individual research divisions have research strategies; however, overall core research strategy is not well communicated by NSF. External evaluations of programs have generally produced positive reviews while occasionally identifying areas for improvement.

Program	Assessment	Explanation
Education and Human Resources	**Moderately Effective**	An overall strategy for NSF's education programs is not well articulated. External evaluations of programs have generally given positive reviews while occasionally identifying areas for improvement.
Major Research Equipment and Facility Construction	**Moderately Effective**	Appropriations account established in 1995 to fund development of major research facilities. New process being implemented to determine priorities among new facility projects. New facility management guidelines are being developed.

Strengthening Management

NSF is a relatively well-run agency. Funding for the agency has grown significantly in the past decade, while the agency's staffing level has remained flat. The agency has accommodated the increase in funding and responsibilities through the use of information technology and continued reliance on outsourcing support of NSF's review process to the academic community. Nevertheless, there are major hurdles on the horizon.

Of the total federal funds NSF receives, 95 percent go to researchers and educators; the agency's overhead is only five percent. Many in Congress and the NSF Inspector General have questioned whether the agency has enough resources to adequately manage its growing portfolio and conduct adequate oversight of its awards. The 2003 Budget addresses these concerns by providing a significant funding increase to expand award oversight by providing for more travel to review large award recipients, providing additional personnel through temporary and permanent appointments, and enhancing information technology (IT) systems to improve worker productivity and efficiency of the award process.

NSF has been better managed and has a better baseline evaluation than most other agencies. For example, NSF is the only agency to receive the top rating for financial management. NSF is also a federal government leader for e-government and information technology. The growing demands on NSF, however, will require it to further improve its management. In particular, NSF needs to improve results of its human capital management, competitive sourcing, and integration of performance and the budget efforts. A scorecard of NSF's activities for the President's management initiatives follows. The agency is performing well, but there are areas of concern.

Initiative	2001 Status
Human Capital—NSF's human capital strategy is not integrated into its budget and strategic plans and the agency does not implement succession plans. NSF does use staffing flexibilities well, such as those provided in the Intergovernmental Personnel Act. NSF is moving expeditiously to develop a Training Academy and to conduct an Organizational Assessment Survey. The agency also will initiate a significant workforce analysis in 2002. The Foundation is developing a five-year administration and management strategic plan to lay out how it plans to address its workforce issues in the coming years.	
Competitive Sourcing—NSF has not yet launched a viable competitive sourcing initiative. In its 2000 analysis of workforce activities, NSF identified 533 positions as performing commercial functions. NSF has not decided if it will compete any positions at this time. The agency wants to wait until it gets results from its upcoming workforce analysis before it makes a decision on competing positions. At that rate it will be difficult for the agency to meet 2003 competition goals. NSF must develop and submit a competitive sourcing plan to meet near-term goals.	
Financial Management—NSF is the federal leader in financial management and has met all core criteria for a green rating for financial management. NSF's financial management systems meet federal financial management system requirements and it has received unqualified and timely audit opinions on its annual financial statements. NSF expects to maintain this position.	
E-Government—NSF meets most, but not all, of the standard core criteria for expanding E-Government. All major information technology projects provided sufficient business cases. However, NSF's Government Information Security Reform Act report reflects deficiencies in a number of important areas of security. These concerns include failure to implement appropriate security controls to protect critical information and risk of disruption of essential services. NSF has submitted its corrective action plans and will be reallocating 2002 funds to quickly correct identified problems.	
Budget/Performance Integration—NSF's budget does not tie resources to results, provides limited focus on outcomes, and does not charge the full budgetary cost to individual activities. There are inherent difficulties in integrating the budget with performance given the long-term nature of research, in which results may not occur until 10 years or more. Nonetheless, NSF could do more. In Spring 2002, OMB and OSTP will work with major research agencies to develop criteria for evaluating basic research during the formulation of the 2004 Budget.	

National Science Foundation

(In millions of dollars)

	2001 Actual	Estimate	
		2002	2003
Spending:			
Discretionary Budget Authority:			
Research and Related Activities	3,357	3,598	3,783
Education and Human Resources	785	875	908
Major Research Equipment and Facility Construction	122	139	126
Salaries and Expenses	167	176	210
Inspector General	6	7	8
Subtotal, Discretionary budget authority adjusted [1]	4,437	4,795	5,035
Remove contingent adjustments	–6	–6	–7
Total, Discretionary budget authority	4,431	4,789	5,028
Mandatory Outlays:			
H-1B Fee Programs	11	100	97
All other programs	28	45	49
Total, Mandatory outlays	39	145	146

[1] Adjusted to include the full share of accruing employee pensions and annuitants health benefits.

For more information, see Chapter 14, "Preview Report," in *Analytical Perspectives.*