Ideas

In order to achieve the NSF mission, one of the agency's key strategies is to support the most promising ideas in research and education. The expected outcomes of these investments are a robust and growing fundamental knowledge base that enhances progress in all science and engineering areas and partnerships that connect discovery to innovation, learning and societal advancement.

(Millions of Dollars)

	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate
Ideas	$1,849	$1,973	$2,425

FY 2001 support for Ideas totals $2,425 million, an increase of $452 million, or 22.9 percent, above FY 2000. This provides funding for research projects that include researchers and postdoctoral associates as well as undergraduate and graduate assistants. Funds are also provided for items necessary for performing research, such as instrumentation and supplies, and for related costs such as travel and conference support. Research in core disciplinary areas as well as studies within NSF's four initiative areas are included within funding for Ideas. Through outreach activities, NSF seeks out and supports excellent proposals from groups and regions that traditionally have not fully participated in science, mathematics, and engineering.

Support provided primarily to further NSF's other strategic goals, People and Tools, is essential for facilitating Ideas — discovery at and across the frontier of science and engineering. NSF's investment in People promotes the integration of research and education and ensures that the U.S. has world class scientists and engineers, a workforce that is scientifically and mathematically strong, and a public that understands and can take full advantage of basic concepts of science, mathematics, engineering and technology. Support for Tools provides access to state-of-the art facilities and platforms which are essential for world-class research.

In FY 2001, NSF will continue its efforts to increase the average size and duration of awards. These efforts will contribute to increasing the efficiency of the Foundation's merit review process and achieve greater cost-effectiveness for both NSF and the university community. In accord with the Foundation's FY 2001 Performance Plan, NSF will continue to provide increased attention to the participation of new investigators in all our programs.

The FY 2001 Request provides for substantial increases in **core disciplinary research** that extend the frontier of science and engineering across the board. These activities sustain the flow of new discoveries that fuel the development of new technologies.

Areas of emphasis within NSF's core research will include:

- Exploration of links between quantum theory and fundamental mathematics: mathematicians and physicists together are gaining insight into diverse topics, such as the fundamental makeup of matter, the nature of the chemical molecular bond, and the development of new materials.

- Research on the key physical, chemical and geologic cycles within the Earth System: including improved understanding of the primary processes involved in the large-scale water cycle, which will provide knowledge of the regional distribution of water and enhance the ability to predict and prepare for droughts and floods.

- Research in the psychological, cognitive, and language sciences: provides a sharper picture of how human language is acquired and how it is used, both for thought and communication, thus laying the foundation for progress in many areas of national importance, from teaching children how to read to building computers that can talk.

- The Experimental Program to Stimulate Competitive Research (EPSCoR), a State-NSF partnership, will continue to support improvements in academic research competitiveness. In FY 2001, funding for EPSCoR through the Education and Human Resources appropriation totals more than $48 million. Linkages between EPSCoR and other NSF-supported research activities are expected to result in an additional $15-25 million directed to research in EPSCoR states.

- Support for plant genome research will increase by $22.5 million to total $102 million in FY 2001. NSF will use increases in funding to begin the "2010 Project." With the completion of the sequencing of the genome of the model plant *Arabidopsis,* researchers will begin a systematic effort to determine the functions of the 20,000 to 25,000 genes of this flowering plant. Continued support for this research area will advance understanding of the structure, organization and function of plant genomes, with particular attention to economically significant plants, and accelerate utilization of new knowledge and innovative technologies toward a more complete understanding of basic biological processes in plants. The focus in plant genome research will continue to be on functional genomics and on graduate and undergraduate training in plant genomics.

- The Small Business Innovation Research (SBIR) program is supported at the mandated level of at least 2.5 percent of extramural research. The program will total approximately $74.7 million, an increase of approximately $13 million over FY 2000.

Included within support for Ideas are also funds for fundamental research within the Foundation's four initiative areas:

Information Technology Research: Advances in software, networking, scalability, high-end computing, mathematics, research applications, wireless networking, communications and remote sensing will enable the entire science and engineering community to work more productively and to examine issues that were previously too complex to address with the existing technology. Investments in IT will deliver tools and capabilities that will benefit every field, every discipline and people at every level of education. For example, sophisticated techniques for designing and constructing software could ultimately be used by the private sector to develop new markets and to speed reliable and robust information appliances to consumers and information systems to industry. Understanding the social and cultural impacts of technological change could change the scope and manner in which new technologies are deployed, improving our lives and the lives of our children.

Nanoscale Science and Engineering: Nanoscale science and engineering will have a far-reaching impact on technology for the 21st century. The control of matter at the atomic level underpins innovation in critical areas from manufacturing to materials to the environment. Nanotechnology is allowing us to build machines so small that they are rapidly approaching the scale of human cells. For example, nanoscale science and engineering will allow the development of a machine smaller than the head of a pin that could be placed in a person's bloodstream to monitor the health of the heart and blood vessels, thereby obviating strokes and heart attacks.

Biocomplexity in the Environment (BE): Understanding biocomplexity – the dynamic interactions among the Earth's living and physical systems – will help us better understand our environment. Furthermore, such investigations will accelerate cutting-edge capabilities – such as genomics, molecular sequencing, informatics, robotics, remote sensing, and advanced mathematics and modeling. The discoveries emerging from this work will contribute to improved environmental stewardship and will promote innovation in such areas as biotechnology and public health.

21st Century Workforce: We now live in an economy based on knowledge and innovation. The greatest job growth is in areas that demand a solid grounding in science and technology. In this Request, NSF will inaugurate Centers for Learning and Teaching. These investments will fully engage the broad spectrum of America's diverse population to create a science and engineering workforce second to none.

Centers

NSF supports a variety of individual centers and centers programs which contribute to NSF's investment in Ideas. The centers play a key role in furthering the advancement of science and engineering in the U.S., particularly through their encouragement of interdisciplinary research and the integration of research and education. While the programs are diverse, the centers generally share a common commitment:

- To address scientific and engineering questions with a long-term, coordinated research effort. Center programs involve a number of scientists and engineers working together on fundamental research addressing the many facets of complex problems;

- To include a strong educational component that establishes a team-based cross-disciplinary research and education culture to train the nation's next generation of scientists and engineers to be leaders in academe, industry and government; and

- To develop partnerships with industry that help to ensure that research is relevant to national needs and that knowledge migrates into innovations in the private sector.

The center programs which contribute to the Ideas goal are listed below.

(Millions of Dollars)

	Year of Program Initiation	FY 1999 No. of Centers	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate
Engineering Research Centers and Groups	1985	18	$57	$60	$69
Science & Technology Centers	1987	23	$51	$53	$44
Industry/University Cooperative Research Centers	1973	52	$5	$5	$5
State/Industry/University Cooperative Research Centers	1991	6	$2	$1	$1
Centers of Research Excellence in Science and Technology	1987	10	$9	$9	$9
Plant Genome Virtual Centers	1998	23	$31	$31	$31
Materials Research Science and Engineering Centers	1994	28	$48	$52	$58
Center for Ecological Analysis and Synthesis	1995	1	$2	$2	$2
Long-Term Ecological Research Program	1980	21	$16	$17	$17
Earthquake Engineering Research Centers	1988	3	$6	$6	$6
Chemistry Centers	1998	4	$7	$10	$11
Mathematical Sciences Research Institutes	1982	3	$2	$8	$9
Information Technology Centers	2000	NA	$0	$30	$63
Other Centers[2]	NA	4	$5	$3	$10
TOTAL[1]		196	$242	$287	$334

[1] Numbers may not add due to rounding.

[2] Other Centers include the Research Centers on the Human Dimensions of Global Change, the National Consortium on Violence Research, the National Center for Geographic Information and Analysis and Physics Frontiers Centers.

FY 2001 support for centers is $334 million, an increase of approximately $47 million over FY 2000.

- Information Technology Centers, initiated in FY 2000, support fundamental research in information technology that incorporates scientific applications or addresses social, ethical and workforce issues. An increment of $33 million for this program will provide support for an additional 10-11 awards in FY 2001.

- FY 2001 funding for the Engineering Research Centers and Groups (ERC) will increase by approximately $8.7 million to support up to two virtual ERCs and 3-5 groups in nanoscale science and engineering. The ERCs will link cross-disciplinary teams of investigators across institutional boundaries to advance fundamental knowledge in nanoscale science and engineering, develop a wide range of new technologies, and prepare model curricula to educate new generations for this emerging field. The Engineering Research Groups will be formed in nascent areas of nanoscience and engineering that are too immature for a full-scale center investment.

- NSF will continue support for the Science and Technology Centers program. Funding for the second cohort of 23 STCs is being phased down in accordance with plans, while support for the five new centers initiated in FY 1999 will continue.

- Funding for Materials Research Science and Engineering Centers will increase by $6.0 million to support up to four new centers focusing on critical areas such as nanoscience and engineering, information technology, and the interface between materials and biology. An increase of $750,000 in FY 2001, in addition to $3.0 million in redirected funds, will support up to three new Chemistry centers for advanced molecular characterization. The Physics Centers program will be initiated in

FY 2001 at a level of $5 million. This will support up to three centers to catalyze new areas such as atom lasers, quantum information science, computational physics, biological physics, and astrophysics. Within the Mathematical Sciences Research Institutes activity, funding of approximately $8.5 million will provide support for three national institutes.

Additional information for selected centers supported by NSF is provided below:

1999 Estimates for Selected Centers
(Millions of Dollars)

	Number of Participating Institutions	Number of Partners	Total NSF Support	Total Leveraged Support	Number of Participants
Engineering Research Centers and Groups	126	505	$57	$111	8,700
Science & Technology Centers	72	340	$51	$97	3,910
Industry/University Cooperative Research Centers and State/Industry/University/Cooperative Research Centers	98	902	$7	$72	2,550
Centers of Research Excellence in Science and Technology	10	70	$9	$9	2,900
Plant Genome Virtual Centers	50	27	$31	$3	2,800
Materials Research Science and Engineering Centers	75	275	$48	$53	5,500
Long Term Ecological Research Program	153	106	$16	$27	2,290
Earthquake Engineering Research Centers	39	105	$6	$11	382
Chemistry Centers	8	12	$7	$10	350

Number of Participating Institutions: all academic institutions which participate in activities at the centers.
Number of Partners: the total number of non-academic participants, including industry, states, and other federal agencies, at the centers.
Total Leveraged Support: funding for centers from sources other than NSF.
Number of Participants: the total number of people who utilize center facilities; not just persons directly supported by NSF.

FY 2001 Performance Goal for Ideas

The following table summarizes NSF's FY 2001 Performance Goal for Ideas. For additional information, see the FY 2001 Performance Plan.

Outcome Goal	FY 2001-2005 GPRA Strategic Plan	FY 2001 Areas of Emphasis
	NSF is successful when results reported in the period demonstrate sufficient progress in achieving:	
Ideas -- Discovery at and across the frontier of science and engineering, and connections to its use in the service of society.	❖ A robust and growing fundamental knowledge base that enhances progress in all science and engineering areas. ❖ Discoveries that expand the frontiers of science, engineering, and technology. ❖ Partnerships connecting discovery to innovation, learning, and societal advancement. ❖ Research and education processes that are synergistically coupled.	Balance of innovative, risky, interdisciplinary research across all NSF programs. Investments in four initiatives: ◗ Information Technology Research ◗ Nanoscale Science and Engineering ◗ Biocomplexity in the Environment ◗ 21st Century Workforce Investments in non-initiative fundamental research: ◗ Mathematical Research ◗ Functional Genomics ◗ Cognitive Neuroscience

Highlights

NSF investments in fundamental research provide support for cutting-edge research in many fields and help to maintain the nation's capacity to conduct research in science and engineering. Selected examples of accomplishments of NSF-supported investments are described below.

Advances in Computer Security: Researchers are contributing in important ways to solving problems in computer security. Detecting the activities of unauthorized and malicious users of a computer system remains difficult. By combining new profiling and instrumentation techniques researchers have been able to provide convincing evidence that there can be much more sophistication in the identification of intrusive activities than current methods allow. This work has already attracted the attention of industry, as well as security experts at NIST and DARPA.

Early Cancer Detection: An NSF-funded researcher at the University of Texas at Austin has applied fluorescence spectroscopy to the detection of pre-cancerous cells. Her work has led to publication of more than 50 peer-reviewed journal articles, 12 patents, and patent licensing by a start-up company. This new knowledge has led to applications in clinical trials which have demonstrated significantly improved efficacy in detection of early stage cervical cancer as compared to existing technologies. It is this type of breakthrough research that positions the U.S. at the forefront of healthcare delivery worldwide, with potentially significant effects in both developed and developing nations.

Improving Consumer Products: The 1998 National Medal of Science was awarded to an NSF grantee for pioneering work in colloidal and surface phenomena, catalysis, and advanced materials. His research resulted in basic understanding that can be used in a wide range of everyday consumer products that are made up of microscopic particles. As a result of this advanced knowledge we now have improved and stable adhesives, paints, cosmetics, and memory and display devices in electronic products. The research on these very minute particles has led to the development of unique materials that enable petroleum refineries and chemical manufacturing plants to produce improved gasoline and other consumer chemicals. These materials help reduce the unnecessary waste of raw materials, energy, and pollution.

Dinosaurs in the Antarctic: Research supported by NSF's Office of Polar Programs led to the discovery of fossil bones of Hadrosaur and Mosasaur dinosaurs on the Antarctic Peninsula. This finding was awarded "Discovery of the Year" by the Royal Geographic Society of London. The findings are important because current knowledge about these dinosaurs is based mostly on North American fossil sites. Finding the remains of the Hadrosaur, a large terrestrial herbivore, is important because the presence of this animal implies a robust and productive vegetation component of the Antarctic ecosystem.

Discoveries in How the Young Learn: NSF-supported findings in infant cognition have radically altered our picture of early development. To probe the infant's mind, researchers have used innovative methods that rely on a simple and reliable behavior: infants will look longer at unexpected events. Using this principle, researchers have examined infants' concepts of the "object," and of everyday things (such as a cat, dog, or chair). The research shows that infants can track objects through space and time, even as they move behind a screen and then become visible again. They can also enumerate small numbers of objects, suggesting they develop some basic knowledge of numbers at an early age.

Predicting Storms: High-impact weather causes economic losses in the U.S. that average $300 million per week. The mission of the NSF-funded Center for the Analysis and Prediction of Storms is to demonstrate the practicability of numerical weather prediction of storms and to develop, test, and validate a regional forecast system appropriate for operational, commercial, and research applications. The May 3, 1999 tornado outbreak in Central Oklahoma was used to test the storm model. The storm-scale forecast showed substantially increased precision. The project generated short-range high-resolution forecasts that dramatically out-performed the National Weather Service forecast during the tornado outbreak. As this forecasting capability is further developed, it will become a critical tool in determining which areas will be most severely hit by storms thereby allowing timely warnings to be issued to persons in affected areas. The commercial airlines industry, power and communications industries, surface transportation, agriculture, defense and space flight, construction, insurance and recreation industries will clearly benefit, as well as the National Weather Service and the general public.

Biomaterial to Extend the Life of Heart Valves: Over 60,000 artificial valves are implanted every year in the U.S., and this has led to extended productive life spans for millions. Despite considerable achievements in the development of both tissue and metallic valve prostheses, the formation of calcium deposits progressively reduces the flexibility of both types of valves and limits their functional lives. A team of biologists and bioengineers at the NSF-supported Engineering Research Center for Engineered Biomaterials has discovered that osteopontin, an adhesive protein, is a potent inhibitor of calcification. These findings suggest that osteopontin may not simply block crystal growth, but may promote mineral regression through active cellular processes. A practical solution to the bioprosthetic calcification problem would save as much as $25 million annually from eliminated valve replacement operations, with annual sales of improved heart valves in the range of $100 million.

Long-Term Environmental Research Impacts Urban Planning: Long-term research on stream ecosystems at the Luquillo LTER site established a strong cause and effect relationship between freshwater shrimp production and streamflow. Based on their studies, LTER scientists advised land planners that a proposed plan to dam streams to create a drinking water reservoir for the city of San Juan, Puerto Rico, would prevent the movement of shrimp upstream and decimate the shrimp fishery. Working together, scientists and planners devised a new plan to install intake pipes and reduce the amount of water to be diverted from the streams that not only provided the water needed for San Juan but also allowed for the sustained production of shrimp. This example demonstrates how long-term research and an understanding of biocomplexity can inform policy and management decisions resulting in a compromise that benefits both natural and social systems.

Sustainability of Arctic Villages: Results from an NSF-supported long-term interdisciplinary study involving eight natural and social science disciplines have provided a combined assessment of the effects of predicted global warming, oil development, tourism, and government cutbacks on the sustainability of Arctic villages in the range of the Porcupine Caribou Herd. The effects of global change on the tundra food sources for caribou on the Alaskan North Slope and elsewhere are critically important to Native villages where a subsistence lifestyle is practiced either as a necessity for survival or as a cultural choice. The study has gone to great lengths to involve both Western and local traditional ecological knowledge to develop a synthesis model to produce a regional integrated assessment that can be accepted by the Native communities and used to examine future scenarios for change in an area undergoing rapid climate and cultural changes.

Laser Sources for Surgical Applications: When ultrafast laser pulses interact with materials, they can remove an area with minimal collateral damage, creating a narrow, well-defined “cut” within the material. Simple, compact femtosecond laser sources, when used in surgical procedures, offer the potential for performing highly controlled and targeted incisions, thereby increasing the efficiency and safety of the surgical procedure. Researchers at the Center for Ultrafast Optical Science have pursued exploratory studies in the use of femtosecond lasers for eye surgery. Now, a spin-off company from the Center has developed the first such commercial product, a laser system for use in refractive surgery that is currently undergoing clinical trials.

World-Wide Web Searching: The leading approaches to searching the World Wide Web (WWW) were developed with NSF support. The Excite search engine was initiated in the Webcrawler project at the University of Washington. The Lycos search engine was the result of an NSF funded project at Carnegie Mellon University. The Inktomi search engine, now used in products by Yahoo!, HotBot, Snap! and other consumer engines, was developed on an innovative cluster supercomputer built at the University of California at Berkeley. Infoseek resulted from an NSF-supported project at the University of Massachusetts. Specialized search engines, such as Thomas, used by the Library of Congress, also have their origins in NSF-funded research at Cornell University. The browsers that access the data resources of the WWW also owe their origins to a project at NCSA, an NSF-funded Supercomputer Center at the University of Illinois.