Ideas

Enabling "discovery across the frontier of science and engineering, connected to learning, innovation, and service to society."

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

(Millions of Dollars)

	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate
Ideas	$2,297	$2,431	$2,560

FY 2003 support for Ideas totals $2.56 billion, an increase of $128.37 million, or 5.3 percent, above FY 2002. This provides funding for research projects that support 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 six priority 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 outcomes, People and Tools, is essential for facilitating Ideas – discovery across the frontier of science and engineering, connected to learning, innovation, and service to society. 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 2003, NSF will continue its efforts to increase the average size of awards. This effort 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.

The FY 2003 Request focuses on areas that build strength in the science and engineering disciplines, enable the development of new and emerging fields, and provide leadership to improve the health and continued vitality of the nation's science, technology, engineering, and mathematics (STEM) research and education enterprise.

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

- CyberTrust Security focuses on research to understand and build systems that can be trusted. Elements of "trust" include privacy (keeping unauthorized people out of systems), integrity (assuring that messages received or files read are not corrupted), authentication (techniques to really know who you are communicating with), and availability (making sure that systems are available to do the intended jobs; preventing denial of service attacks.)

- The 21st Century Biology combines theory, experiments, informatics, and technologies for an integrative systems approach to biological research, which is becoming increasingly multidisciplinary, multidimensional, information driven, and education-oriented.

- Sub-glacial lake exploration emphasizes instrumentation development for measuring the physical parameters in Antarctic sub-glacial lakes that have been buried under thousands of meters of ice for millions of years, and for remote sampling of microscopic life forms.

- Sensor technologies include nano/micro-scale sensors, wireless communications, functional materials with selective absorption capabilities, and nondestructive evaluations and remote sensing. An increase in core funding will enhance homeland security capabilities while creating a workforce knowledgeable in the operation and deployment of these technologies.

- Behavioral and cognitive sciences involve human cognition including work in the multidisciplinary field of cognitive neuroscience, computational linguistics, and research tracing human biological and behavioral changes over time.

- Natural hazards research incorporates multidisciplinary approaches for examining natural hazards in the U.S., including earthquakes, floods, and tornadoes to further our understanding of these phenomena and to work toward reducing their social and economic costs.

- Quantum information science is a new field of science and technology. It aims to understand how certain fundamental laws of physics discovered early in the twentieth century can be harnessed to dramatically improve the acquisition, transmission, and processing of information by combining and drawing on the disciplines of physical science, mathematics, computer science, and engineering.

- Core research in mathematics involves the transfer of results and applications between mathematics and statistics research and the science and engineering disciplines, challenges the limits of current mathematical theories, and develops a new cadre of researchers who are trained in both mathematics and science.

- The Experimental Program to Stimulate Competitive Research (EPSCoR), a State-NSF partnership, will continue to support improvements in academic research competitiveness. In FY 2003, funding for EPSCoR through the Education and Human Resources Appropriation totals $75.0 million. Linkages between EPSCoR and other NSF-supported research activities are expected to result in up to $30 million in additional funding directed to research in EPSCoR states.

- The Small Business Innovation Research (SBIR) program and Small Business Technology Transfer (STTR) program are supported at the mandated level of at least 2.5 percent of extramural research. SBIR will total $78.98 million, an increase of 3.9 percent over FY 2002, and STTR will total $4.67 million, an increase of 3.8 percent over FY 2002.

- Hydrology of Toxic Substances involves a transfer of $10.0 million from the U.S. Geological Survey (USGS) National Research Program of Water Resources Investigations to NSF. NSF will establish a new study-area within the Hydrologic Sciences Program focused on the science of water quality at the interface of natural and human systems. Based on the USGS Toxics Program, this new effort in water quality will be reoriented to focus on the fundamental processes affecting water quality.

- The Sea Grant Program involves a transfer of $57.0 million from the National Oceanic and Atmospheric Administration (NOAA) to NSF. NSF will operate it as a competitive merit-based research, education, and outreach program focused on development of marine resources.

Also included within support for Ideas are funds for fundamental research within the Foundation's six priority areas; Biocomplexity in the Environment; Information Technology Research; Nanoscale Science and Engineering; Learning for the 21st Century Workforce; Mathematical Sciences; and Social, Behavioral and Economic Sciences.

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 common commitments:

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

- To include a strong educational component that establishes a team-based cross-disciplinary research and education culture to educate 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 and education are 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)

	Program Initiation (year)	FY 2001 # of Centers	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate
Engineering Research Centers	1985	32	$63	$62	$62
Science & Technology Centers	1987	17	$40	$45	$45
Industry/University Cooperative Research Centers	1973	53	$5	$5	$5
State/Industry/University Cooperative Research Centers	1991	3	$1	$1	$1
Centers of Research Excellence in Science and Technology	1987	10	$9	$9	$9
Plant Genome Virtual Centers	1998	22	$31	$31	$31
Materials Centers	1994	29	$50	$53	$53
Center for Ecological Analysis and Synthesis	1995	1	$2	$3	$3
Long-Term Ecological Research Program	1980	24	$18	$18	$19
Earthquake Engineering Research Centers	1988	3	$6	$6	$6
Chemistry Centers	1998	13	$8	$14	$10
Mathematical Sciences Research Institutes	1982	3	$9	$13	$14
Information Technology Centers	2000	66	$59	$68	$70
Nanoscale Science and Engineering Centers	2001	6	$13	$14	$14
Physics Frontiers Centers	2003	3	$7	$12	$13
Science of Learning Centers	2003	-	-	-	$20
SBE Centers[1]	NA	6	$6	$6	$5
TOTAL		291	$327	$359	$380

Totals may not add due to rounding.

[1] SBE Centers include the Research Centers on the Human Dimensions of Global Change, the National Consortium on Violence Research, and Children's Research Centers.

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

FY 2001 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	147	515	$63	$140	3,634
Science & Technology Centers	106	121	$40	$45	2,877
Industry/University Cooperative Research Centers and State/Industry/University Cooperative Research Centers	114	772	$6	$69	2,038
Centers of Research Excellence in Science and Technology	62	44	$9	$9	2,900
Plant Genome Virtual Centers	70	22	$31	$6	2,800
Materials Centers	82	285	$50	$68	5,515
Long Term Ecological Research Program	178	117	$18	$43	2,578
Earthquake Engineering Research Centers	111	40	$6	$14	392
Physics Frontiers Centers	3	-	$7	$1	100
Chemistry Centers	52	75	$8	$2	630

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.

Description of NSF Centers

Engineering Research Centers

The Engineering Research Centers (ERC) program stands as a landmark in federal support for university research and education in partnership with industry. These centers provide an environment where academe and industry can focus together on advances in the complex engineered systems that transform industrial processing systems and product lines most important for the Nation's future. ERCs bring diverse engineering and scientific disciplines together to address fundamental research issues at the interface between the discovery-driven culture of science and the innovation-driven culture of engineering. They provide the intellectual foundation for industry collaboration with faculty and students to resolve generic, long-range challenges, producing the knowledge needed to ensure steady advances in technology, speed their transition to the marketplace, and train graduates who are effective in applying them in industry.

ERCs are also devoted to the integration of research and education by creating team environments for learning and research and producing curricula and course materials for bioengineering, multimedia information systems, manufacturing, electronic packaging, and particle science and technology, among others. In addition, all ERCs have active programs to stimulate interest in engineering with pre-college students and their teachers and several have sites at local museums to educate the general public about engineering and technology.

NSF support of $63 million in FY 2001 was leveraged by an additional $140 million in support from industry, other federal agencies, the universities, and ten states. These 515 firms involved partnerships and collaborations in research with faculty from 147 institutions in the U.S. and abroad. In FY 2003, NSF will provide a total of approximately $62 million, level funding with FY 2002, to support 19 centers across a broad range of technologies, including three Nanoscale Science and Engineering Centers and up to two new ERCs.

Science and Technology Centers

The Science and Technology Centers (STC) Integrative Partnerships Program supports innovation in the integrated conduct of research, education, and knowledge transfer in fields of basic science, mathematics, and engineering. STCs foster partnerships that build a new collaborative culture among researchers and educators at all levels in academia, industry, government laboratories, and other public and private organizations. The Centers provide opportunities to explore challenging and complex research problems that often require interdisciplinary expertise and high-risk approaches, access to state-of-the-art instrumentation and facilities, and a commitment of high levels of support for sustained periods of time. It is estimated that STC funding from other sources totaled approximately $44.9 million in FY 2001.

STCs have an impressive record of research accomplishments, research training, contributions to K-12 education, and timely transfer of knowledge and technology from the laboratory to industry and other sectors. Traditional barriers among disciplines and among university, governmental, and industrial laboratories have been reduced, creating a new mode of leadership and management in research and education. STCs have engaged the nation’s intellectual talent, robustly drawn from its full human diversity, in the conduct of research and education activities; enabled the training of undergraduate students, graduate students, and postdoctoral fellows; involved scores of industrial researchers in basic research; and spawned new companies, products, and jobs.

STCs also create partnerships and programs that transfer knowledge in service to society with respect to new research areas, promising new instrumentation, and potential new technologies. For example, adaptive optics technology is being developed to investigate how far the correction of visual aberrations can extend the limits of human vision through customized contact lenses and improved laser refractive surgical procedures. NSF's FY 2003 support for the STC program is approximately $45 million.

Industry/University Cooperative Research Centers and State/Industry/University Cooperative Research Centers

Industry depends on the Industry/University Cooperative Research Centers (I/UCRCs) and State I/UCRCs to provide a steady stream of enabling technologies critical to advancing their manufacturing processes, information technology support systems, and new product lines. In FY 2001, there were 56 of these highly-leveraged centers, representing a total NSF investment about $6 million. NSF's investment generated $69 million in additional cash and substantial "in-kind" contributions for the centers. Another indication of high payoff from the supporters of the I/UCRCs is that they have invested over $160 million per year to fund follow-up internal research and implementation activities in their organizations as a result of the centers' research results.

In FY 2003, NSF will provide approximately $6 million for the Industry/University Cooperative Research Centers program, providing support to 54 traditional I/UCRCs and the three remaining State I/UCRCs.

Centers of Research Excellence in Science and Technology

The Centers of Research Excellence in Science and Technology (CREST) program upgrades the research capabilities of the most productive minority institutions. Through strong alliances with other universities and laboratories, the Centers produce new knowledge and increase student presence in science, technology, engineering, and mathematics in their region. NSF will provide about $9 million for CREST in FY 2003. This funding level will support nine Centers and an additional special research Center to help faculty participate more fully in NSF's other research programs.

Plant Genome Virtual Centers

The Plant Genome Research subactivity supported twenty-two Plant Genome Collaboratories or Virtual Centers in FY 2001 at a total investment of $31 million. These are multi-institutional networks where coordinated, multi-disciplinary investigator teams pursue comprehensive, interdisciplinary research on the structure, organization and function of plant genomes relevant to economically important plants or plant processes. NSF support for Plant Genome Virtual Centers in FY 2003 will total $31 million.

Of 22 Centers supported in FY 2001, 16 are continuations of awards made earlier; 4 are successful renewals of virtual centers initiated in FY 1998; and 2 are newly established centers. The 22 Centers involve 222 scientists as key personnel with a large number of postdoctoral fellows, graduate students, undergraduate students, technical personnel, and others involved. Key participants are located at 70 institutions in 27 States. International collaborators are involved in a number of areas of center research including the potato, wheat, and model legume projects.

One of the two new awards will investigate the genetic control of form and function in flowers, from flowering to seed production. The objective is to characterize the genes controlling the differentiation of flower cells and examine genes that play a central role in development of plant features. The project takes full advantage of data, information, technologies and research resources produced by the recipients of the Plant Genome Research Program during the last four years.

Materials Centers

The Materials Centers program supports interdisciplinary materials research addressing fundamental problems of intellectual and strategic importance. The centers have strong links to industry and other sectors, and support educational partnerships with other institutions. There were 29 Materials Research Science and Engineering Centers within this program in FY 2001, and an open competition for new and recompeting centers is underway in FY 2002. Annual NSF support for individual centers ranges from less than $1.0 million to more than $4.0 million. Additional support from non-NSF sources for these centers totaled $68 million in FY 2001. NSF's FY 2003 support for the program is approximately $53 million. Support will be continued for up to three new International Materials Institutes established in FY 2002 to foster and enhance interaction in materials research and education between U.S. and foreign investigators.

Materials Centers include broad-based centers with diverse research agendas as well as those which are more focused. The centers feature cutting-edge materials research in areas such as polymers, biomimetic and biomolecular materials, nanostructured materials, electronic and photonic materials, superconducting and superhard materials, oxide surfaces and magnetic systems, micromechanical systems, magnetic materials, sensors, deformation and fracture, materials synthesis and processing, and fundamental condensed-matter phenomena.

Center For Ecological Analysis and Synthesis

The Center for Ecological Analysis and Synthesis (CEAS) at the University of California at Santa Barbara promotes integrative studies of complex ecological questions and serves as a locus for the synthesis of large data sets. The goals of the Center are to advance the state of ecological knowledge through the search for universal patterns and principles and to organize and synthesize ecological information so that it will be useful to researchers, policy makers and resource managers addressing important environmental problems. NSF's FY 2003 support for the CEAS program is about $3 million.

Long Term Ecological Research Program

The Long Term Ecological Research (LTER) program supports long-term analysis of ecological phenomena, both natural and human influenced; comparisons of observations across diverse ecosystems; integration of information from multiple sites and multidisciplinary projects through cross-site syntheses; and provision of large, secure, ecologically diverse sites with well-developed support capabilities. Extensive computer networking allows regional, national and international synthesis efforts.

In FY 2002 NSF is supporting 24 LTER sites that are representative of major ecosystems, including two sites in Antarctica and two in Alaska, one in Arctic Alaska. The LTER Program has taken the lead in establishing a worldwide ecological research network by electronically linking the U.S. LTER network with research sites in Europe, Latin America, and the Asia/Pacific region.

NSF's FY 2003 support for the LTER program is approximately $19 million.

Earthquake Engineering Research Centers

The three Earthquake Engineering Research Centers (EERCs) focus at the systems level, integrate research and education, and develop partnerships with industry and the public agencies responsible for earthquake hazard mitigation at the local, state and federal levels.

The EERCs link geological information about the nature of earthquake hazards in different regions of the country with geotechnical and structural engineering knowledge to provide state-of-the-art structural design methodologies. They provide the knowledge and technology base for industry and public agencies to build and retrofit buildings, bridges, and other infrastructure to better withstand the impacts of earthquakes. Because these centers involve partnerships among social scientists and engineers, they are developing a new generation of decision tools to improve public service agencies' planning for earthquake hazard mitigation and their responses during earthquake emergencies.

EERCs are rapidly becoming major contributors in the field both in the U.S. and internationally. In FY 2001, NSF provided a total of approximately $6 million to three EERCs, which leveraged this support with $14.0 million from universities, three states, and industry. FY 2003 support is maintained at $6 million.

Chemistry Centers

Chemistry Centers include the Environmental Molecular Sciences Institutes, the Collaborative Research Activities in Environmental Molecular Sciences, Collaborative Research in Chemistry, and the Center for Molecular Sciences. These centers support a wide range of activities from developing a molecular understanding of the environment to investigation of fundamental steps in chemical reactions. In FY 2003, NSF will provide approximately $10 million to support these centers.

Mathematical Sciences Research Institutes

The institutes provide a national resource for in-depth research in the mathematical sciences and for exciting multidisciplinary research between mathematical scientists and other scientists and engineers from academia, industry, and government laboratories. Significant postdoctoral experiences are nurtured through mentoring with world-class mathematical scientists and through opportunities with partner universities, industries, and government laboratories. In FY 2003, NSF will provide about $14 million for up to three new institutes in interdisciplinary mathematical sciences.

Information Technology Centers

As part of the Information Technology Research (ITR) program begun in FY 2000, NSF began support for 33 new center projects. These focus on major challenges for information technology research and often address interdisciplinary themes. In FY 2001, the number of center projects increased by about 100 percent. In FY 2002, 3-5 new centers will be initiated. In support of their long-term mission, some centers will develop testbeds and may include education and outreach components. Other centers will be virtual centers that join geographically separate investigators with individualized expertise or instrumentation linked by high-performance networks. Some of these virtual centers will foster research on distributed computing and applications. In FY 2003, NSF will fund the Information Technology Research Centers at the level of approximately $70 million.

Nanoscale Science and Engineering Centers

As part of the multiagency National Nanotechnology Initiative, NSF awarded six new centers in FY 2001. Research and education are focused on a scale ranging from the size of individual atoms to that of large molecules. Research at the nanoscale aims to advance the development of the ultra-small technology that will transform electronics, materials, medicine, environment and many other fields. Each center has a long-term vision for research, and together they will provide coherence and a long-term outlook to U.S. nanotechnology research and education. Support will be provided for education and outreach programs

from the graduate to the K-12 level designed to develop a highly skilled workforce, advance pre-college training, and to advance the public understanding of nanoscale science and engineering. The centers have strong partnerships with industry, national laboratories and international centers of excellence. In FY 2003, NSF will provide continuing support to the six centers at approximately $14 million.

Physics Frontiers Centers

The Physics Frontiers Centers program was initiated in FY 2001. These centers provide critical resources and needed infrastructure to exceptionally promising new areas of physics. They serve as focal points to help catalyze new fields, with the resources and infrastructure to enable development of the new tools and techniques needed, and to facilitate exploration of new directions in a way that is not practical in individual investigator awards. Areas such as atom lasers, quantum information science, computational physics, biological physics, and astrophysics are particularly promising for such an investment. Interdisciplinary research will be a key element of this program, and each center will have a significant outreach and infrastructure component. In FY 2003, NSF will provide a total of $13.0 million, an increase of $1.0 million, for support of seven Centers. The program is expected to grow in subsequent years through additional competitions, in which existing Centers will periodically be required to recompete.

Science of Learning Centers

NSF's investment in Science of Learning Centers (SLC), set to begin in FY 2003, will build on the Foundation's support for learning research in multiple disciplines including biology, psychology, education, neuroscience, cognitive science, linguistics, computer and information science, robotics, mathematics and statistics, engineering, the physical sciences, and the social and behavioral sciences. SLCs will be organized around a unifying research focus and an effective implementation strategy that will achieve all three of the SLC principal goals: (1) advancing the understanding of learning, through research on the learning process, the context of learning, and/or learning technologies; (2) strengthening the connections between science of learning research and educational and workforce development, in a manner that mutually advances both; and (3) building effective collaborative research communities with sufficient resources and organizational capacity to respond to new educational and workforce challenges, and capitalize on new research opportunities and discoveries. FY 2003 support for the SLCs totals $20.0 million.

Research Centers on the Human Dimensions of Global Change

NSF has supported a consortium of Research Centers on the Human Dimensions of Global Change since FY 1995. The goals of these centers are to facilitate the progress of Human Dimensions of Global Change (HDGC) research; promote the education and training of researchers ranging from undergraduate to postdoctoral levels; and foster interdisciplinary and multidisciplinary research collaborations on HDGC issues. NSF's FY 2003 support for the two HDGC centers totals $2.30 million, a $1.0 million reduction from FY 2002. This reduction is part of a planned phase-down in core support for these centers.

National Consortium on Violence Research

NSF supports the National Consortium on Violence Research (NCOVR), which is engaged in a program of capacity building in the violence research community. The Consortium's activities focus on training the next generation of researchers in interdisciplinary approaches to understanding interpersonal violence and to increase the participation of underrepresented groups in research on violence. NCOVR also seeks to facilitate collaborative methodological research and the promotion of intellectual exchange that cuts

across disciplines. NSF expects to provide about $1.0 million in support for the Consortium in FY 2002. Support for FY 2003, contingent on review of a renewal proposal in 2003, will be $1.0 million.

Children's Research Centers

The Children's Research Initiative (CRI) received new emphasis in FY 2001 to support a variety of research activities in areas of human sciences. Most prominent under CRI are three research centers that are funded at $500,000 each for 5 years. Together, these centers represent a new thrust in the field of integrative developmental science. Individually, the centers represent leading edge research about children and media, developmental science, and the integration and dissemination of developmental science to inform both research and policy. Centers are located at the University of North Carolina and Cornell University. A third center is a collaboration among four universities: Georgetown University, Northwestern University, University of Texas-Austin, and University of California-Los Angeles

FY 2003 GPRA Performance Goal (Ideas)

The following table summarizes NSF's FY 2003 Performance Goal for Ideas. For additional information, see the FY 2003 Performance Plan.

Strategic Outcome	**No. Annual Performance Goal for Strategic Outcomes**[1]	**FY 2003 Areas of Emphasis**	
		For investment in emerging opportunities:	**For GPRA reporting, as relevant:**
IDEAS **<u>Outcome Goal:</u> Enabling "discovery across the frontier of science and engineering, connected to learning, innovation, and service to society."**	**III-2** ***NSF's performance[2] for the Ideas Strategic Outcome is successful when, in the aggregate, results reported in the period demonstrate significant achievement in the majority of the following indicators:*** • Discoveries that expand the frontiers of science, engineering, or technology; • Connections between discoveries and their use in service to society; • Partnerships that enable the flow of ideas among the academic, public or private sectors; and • Leadership in fostering newly developing or emerging areas.	❑ Priority areas: - Biocomplexity in the Environment - Information Technology Research - Nanoscale Science and Engineering - Learning for the 21st Century Workforce - Science of Learning Centers (SLC) - Mathematical Sciences - Social, Behavioral and Economic Sciences ❑ Core research and education activities ❑ Climate Change Research Initiative (CCRI)	❑ Balance of portfolio, including projects that are innovative, high-risk, or multidisciplinary ❑ Priority Areas: e.g., <u>Current</u> - Biocomplexity in the Environment - Information Technology Research - Nanoscale Science and Engineering <u>Former</u> - Life and Earth's Environment - Information Technology for the 21st Century - Knowledge and Distributed Intelligence ❑ Core research and education activities ❑ Centers, e.g., - STCs, ERCs, MRSECs. ❑ EPSCoR

[1] This performance goal is stated in the alternate form provided for in GPRA legislation.
[2] For individual programs, performance assessment in practice refers to a majority of relevant indicators only.

Highlights of Recent Accomplishments (Ideas)

NSF investments in fundamental research provide support for cutting-edge research and education 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.

World Trade Center Response. In the wake of the tragic events of September 11, 2001, NSF has responded in a wide variety of ways, ranging from the development of displays and workshops set in public venues, to direct consultation on timely engineering and societal issues. Perhaps the most dramatic examples stem from the leadership provided by the research community. With a record response time, NSF allocated $300,000 within 3 weeks to support over half-a-dozen awards to allow researchers to access critical data from 'Ground Zero' in a timely manner. Projects included the 'Forensic Study of Steel and Fire Protection from the World Trade Center Collapse' and 'Palm Pilot/GPS-Digital Data Collection for Damage Assessment.' Early access to the WTC site allowed for critical analysis of structural failure and the development of future strategies to prevent such failures. NSF also worked with the Quick Response Research Program of the Natural Hazards Research and Applications Information Center to fund studies of the aftermath of the September 11th attacks in New York City and Washington, D.C.

Advances in the immune responses of shrimp. The Experimental Program to Stimulate Competitive Research (EPSCoR) supports an Integrative Research Program in Marine Genomics in South Carolina that is designed to analyze the shrimp host response to infection and stress at the level of gene expression, using a functional genomics approach. Although shrimp are susceptible to viral diseases that affect both commercially aquacultured and wild shrimp in the Atlantic coastal fishery, little is known about their immune systems and how they fight viral infections. Over 40 immune-function genes in both Pacific and Atlantic white shrimp have been identified, advancing our knowledge and permitting direct studies of shrimp immune responses to viral infection. Atlantic shrimp are the staple of the shrimp fishery industry in South Carolina.

Beyond DNA Sequencing. DNA sequence data is an essential tool but is not enough to tell us everything about how an organism develops and functions. Building on the large and growing store of information amassed in the international sequence databases, biologists are now able to tackle the next frontier in biology, functional genomics, which combines genome sequence information with data from other biological research to study what genes do - that is, how patterns of sequence are related to patterns of function. NSF's first major program in functional genomics, the "2010 Project" began in FY 2001, and will continue through the year 2010. Its goal is to determine the functions of the 25,000 genes of the flowering plant, *Arabidopsis thaliana*. The 28 newly funded projects include participants from 43 institutions in 20 states. The awards total $43.8 million over four years and are the first under this activity. One example of the projects funded researchers from New York University, the University of California-San Diego, and the University of Illinois at Urbana-Champaign to apply the latest bioinformatic software tools to create a publicly accessible web database cataloguing gene functions related to nitrogen metabolism. Because nitrogen is a key element in the growth of all plants, this research will have a broad impact on the understanding of plant development.

Space Weather Disturbs Earth's Magnetic Field. The Antarctic network of surface magnetometers has produced new insights into the triggering of plasma instabilities by ultra-low frequency waves in the Earth's magnetic field. Disturbances in the solar wind that arrive at the Earth within minutes to days after a violent event on the Sun are referred to as space weather. The largest space weather disturbances are produced by coronal mass ejections and fast solar wind streams emanating from coronal holes, which distort the Earth's magnetic field and inject energy into the magnetosphere. This produces the aurora but

also relativistic electrons, a source of radio and television interference, hazards to orbiting spacecraft, and current surges in power lines.

Thinning Arctic Sea Ice Cover. The cause of a rapid, decade-long thinning of Arctic Ocean sea ice in the 1990s, which has been widely reported in the press in the past two years, is largely attributed to changes in atmospheric circulation. The potential disappearance of the sea ice is critical to understanding future climates because of the role of surface reflectance from snow and sea ice in the Arctic in global climate change feedbacks.

New Power Source for Pentium IV Chips. A collaborative research project between the Center for Power Electronic Systems based at Virginia Tech and five of its industrial collaborators including Intel made a significant advance in power management for future generations of microprocessors. They developed a multi-phased voltage regulator module which resulted in a four fold improvement in power efficiency in a chip. Today every Intel chip is powered by this multi-phased approach to power management.

Visualization of Power Systems Optimizes Performance. The Industry/University Collaborative Research Center for Power Systems Engineering, a consortium of eleven universities with Cornell in the lead, is helping the power industry deal with power management in a deregulated environment. The center developed a power system reliability and cost efficiency simulation program that is being implemented by two power utilities. One of the utilities, the Tennessee Valley Authority (TVA), reports that the simulations and the visualization of the results are helping to optimize the performance of its power distribution system, while making significant savings in power supply costs.

Extra-solar Planets. A major impetus to the observational and theoretical studies of the formation of stars and their planetary disks has been provided in the last few years by the discovery of extra-solar planets. The most recent discovery, by the team from the University of California at Berkeley, the Carnegie Institute of Washington, and the University of California at Santa Cruz, found a planet three-quarters the mass of Jupiter in a circular orbit around the solar-like star 47 Ursa Majoris. Although 70 extra-solar planets have been found thus far, this is the first system with two planets in circular orbits, and at distances that make the planetary system similar to our own.

Fast Lightning. The National Center for Atmospheric Research scientist Eric Defer has analyzed data on a set of short-duration intra-cloud lightning flashes that last only 23 millionths of a second, illuminating a new class of lightning that is thousands of times faster than those previously observed. An intra-cloud flash on average lasts about a quarter of a second. Cloud-to-ground lightning flashes can last more than a second. Researchers found that out of about 5,400 flashes observed, only 83 were cloud-to-ground. More than 800 intra-cloud flashes had durations of less than a millisecond. Many of these lasted no more than 23 microseconds. Researchers do not understand what makes these flashes so short-lived. This is the first analysis relating such flashes to radar output. The short-duration lightning tends to occur at heights of 6 to 10 kilometers (4-7 miles) within the storm, in close proximity to the strongest updrafts and the most intense radar reflectivities found at those heights. It is hoped that eventually these ultraquick flashes might someday serve as a real-time tool for judging storm severity.

Students and Faculty Study Population Dynamics. The California State University at Los Angeles (CSULA) Center for Environmental Analysis (CEA-CREST) established a strong partnership with the NSF National Center for Ecological Analysis and Synthesis at the University of California - Santa Barbara (UCSB) that has resulted in formation of a workgroup on spatially structured dynamics involving Stanford University, UC - Berkeley, UCSB and CSULA. This collaboration exposes CEA-CREST students and faculty to the nation's top experts on modeling population dynamics in marine landscapes.

New Database to Save Endangered Languages. The emergence of English and Spanish as the dominant languages of global commerce is causing many other tongues to fall into disuse. This trend alarms social scientists worldwide because linguistic research not only provides cultural information, but also insight into the diverse capabilities of the human mind. To combat the decrease in the number and diversity of languages and to capitalize on a growing store of digitized linguistic data, a team of NSF-funded researchers at Wayne State University, Eastern Michigan University, the University of Pennsylvania, and the University of Arizona is developing an endangered languages database and a central information server that will allow users to access the material remotely by computer. The project will collect data on endangered languages and devise a Web-based protocol so that new and existing data will be accessible to researchers and native speakers everywhere.