NSF INVESTMENTS AND STRATEGIC GOALS

NSF Investments and Strategic Goals

The National Science Foundation's FY 2005 funding request supports the agency's investment in *People*, *Ideas*, *Tools*, and *Organizational Excellence* – the Foundation's four strategic outcome goals. These goals flow from NSF's statutory mission, "to promote the progress of science…." and they form the basis for the many activities of the Foundation. These goals, along with their associated investment categories and objectives, provide a results-oriented focus for NSF's investments, and a framework for assessing overall program performance. NSF's investments in *People*, *Ideas*, and *Tools* work in concert to promote progress in all aspects of science and engineering research and education, and are underpinned by investments in *Organizational Excellence*.

- *People* - A diverse, competitive, and globally-engaged U.S. workforce of scientists, engineers, technologists and well-prepared citizens.
- *Ideas* - Discovery across the frontier of science and engineering, connected to learning, innovation and service to society.
- *Tools* - Broadly accessible, state-of-the-art science and engineering facilities, tools and other infrastructure that enable discovery, learning and innovation.
- *Organizational Excellence* - An agile, innovative organization that fulfills its mission through leadership and state-of-the-art business practices.

NSF Budget by Strategic Goal
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
People	1,117	1,134	1,065	-69	-6.1%
Ideas	2,689	2,789	2,845	56	2.0%
Tools	1,313	1,368	1,472	104	7.6%
Organizational Excellence	251	287	363	76	26.4%
Total, NSF[1]	$5,369	$5,578	$5,745	$167	3.0%

Totals may not add due to rounding.

[1]Total does not include $46.57 million in FY 2003 from H-1B Nonimmigrant Petitioner Fees. Legislation for this activity expired in FY 2003 and was not reauthorized.

The NSF Strategic Plan identifies management of the investment process as a critical factor in achieving the agency's goals. NSF strategies for meeting new challenges and carrying out agency goals and mission include:

- Commitment to Organizational Excellence;
- Adequate funding of the Major Research Equipment and Facilities Construction Account;
- Investments in Priority Areas;
- Continued funding to sustain an efficient and enabled research and education community;
- Sustaining a capable and well-trained science and engineering workforce by attracting top U.S. students and broadening participation across science and engineering;
- Supporting Investments in Innovation; and
- Expanded collaborations with international partners.

In addition to investments based on NSF's four Strategic Outcome Goals, the FY 2005 budget is aligned to reflect funding levels associated with the Foundation's ten investment categories. These categories were designed as a mechanism to better enable assessment of program performance and to facilitate budget and performance integration.

NSF Budget by Strategic Outcome Goal and Investment Categories
(Dollars in Millions)

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
People	Individuals	471.53	477.39	498.85	21.46	4.5%
	Institutions	182.54	180.15	172.35	-7.80	-4.3%
	Collaborations	462.93	476.23	393.62	-82.61	-17.3%
		1,117.00	1,133.77	1,064.82	-68.95	-6.1%
Ideas	Fundamental Science and Engineering	2,095.56	2,124.25	2,150.44	26.19	1.2%
	Centers Programs	364.23	413.02	457.26	44.24	10.7%
	Capability Enhancement	229.21	251.72	237.35	-14.37	-5.7%
		2,689.00	2,788.99	2,845.05	56.06	2.0%
Tools	Facilities	538.17	580.21	685.57	105.36	18.2%
	Infrastructure and Instrumentation	336.66	341.52	344.93	3.41	1.0%
	Polar Tools, Facilities and Logistics	252.96	250.24	254.15	3.91	1.6%
	Federally-Funded R&D Centers	184.92	195.92	187.43	-8.49	-4.3%
		1,312.71	1,367.89	1,472.08	104.19	7.6%
Organizational Excellence		250.63	287.18	363.05	75.87	26.4%
Total, NSF		$5,369.33	$5,577.83	$5,745.00	$167.17	3.0%

Totals may not add due to rounding.

Additionally, in FY 2005, NSF resources will support the Administration's five interagency research and development (R&D) investment priorities: Research and Development (R&D) for Combating Terrorism; Nanotechnology; Networking and Information Technology Research and Development; Molecular-level Understanding of Life Processes; and Environment and Energy. Many of NSF's investments map to these important existing and emerging priorities.

Core Research and Education Activities

NSF investments in core research and education activities are targeted to disciplinary and multidisciplinary programs that support the best ideas generated by the academic community. These funds support single investigator and small group awards and also provide primary support for junior faculty and students. They are extremely important in invigorating the research and education community since they promote emergence of new ideas and fields, especially where the defining borders of disciplines are blurring and new technologies are emerging. Investments in the core activities ensure the vitality of scientific and engineering fields in interdisciplinary research and discovery. If the nation is to maintain the health, security, and vitality of its citizens, it must continue to have access to the best science and engineering talent. The National Science Foundation has a critical role in providing this balance for U.S. science and engineering.

Investments in Selected Priority Areas

In addition to investments in core research and education, NSF funding for selected priority areas provides key, agency-wide opportunities for pursuing the strategic outcome goals. Through these priority areas, NSF identifies and accelerates progress in areas of emerging opportunity that hold exceptional promise for advancing knowledge and addressing national interests. Each requires appropriate attention to developing people with new skills and new perspectives; seeking new approaches to knowledge generation across the frontiers of science and engineering; and creating the tools that enable rapid advances.

The FY 2005 Request emphasizes investments in five interdependent priority areas – Biocomplexity in the Environment; Nanoscale Science and Engineering; Mathematical Sciences; Human and Social Dynamics; and Workforce for the 21st Century. In addition, NSF continues to give high priority to Information Technology Research investments, which will be merged in FY 2005 into ongoing research programs across NSF. As a previous NSF priority area, ITR created unprecedented new possibilities for advancing IT knowledge and supported investments that provided state-of-the-art supercomputing resources to U.S. researchers and expanded into new fields of research such as cyberinfrastructure. Within the priority areas, there is a rich mix of activity that integrates areas of fundamental research with elements of practice in related fields. This synergy characterizes the interdependence of the priority areas. For example, concepts and techniques from the mathematical sciences priority area may influence the development of our understanding of biocomplexity or nanoscale science and engineering and vice versa.

NSF Priority Area Investments
(Dollars in Millions)

Priority Area	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Biocomplexity in the Environment	70.28	99.83	99.83	0.00	0.0%
Nanoscale Science and Engineering	222.46	253.51	305.06	51.55	20.3%
Mathematical Sciences	60.42	89.09	89.11	0.02	0.0%
Human and Social Dynamics	4.46	24.24	23.25	-0.99	-4.1%
Workforce for the 21st Century	N/A	N/A	20.00	20.00	N/A
Total, Priority Areas	$357.62	$466.67	$537.25	$70.58	15.1%

Totals may not add due to rounding.

Biocomplexity in the Environment

The world is facing significant scientific and societal challenges, including the prospect of rapid environmental and climatic change, the threat of biological warfare, and the complicated question of long-term environmental security. The integrity of local, regional and global ecosystems is inextricably linked to human well-being while environmental and human health issues often intertwine. Fundamental study of complex environmental systems is therefore a key element of local, national, and global security and critical to the development of new scientific and technological capabilities that will significantly advance our ability to anticipate environmental conditions and thus improve environmental decision-making.

The *Biocomplexity in the Environment* (BE) priority area is designed to give NSF the capability to respond to the demand for new approaches to investigating the interactivity of biota and the environment. Investigations must be highly interdisciplinary, consider non-human biota and/or humans explicitly, and examine challenging systems that have high potential for exhibiting nonlinear or highly-coupled

behaviors. Advanced computational strategies and technologies must be developed and utilized. The term "biocomplexity" is used to stress the requirement that research questions must address the dynamic web of interrelationships that arise when living things at all levels – from their molecular structures to genes to organisms to ecosystems to urban centers – interact with their environment. This priority area will result in more complete and synthetic understanding of natural processes, of human behaviors and decisions in the natural world, and ways to use new technology effectively to sustain life on earth.

An important new emphasis in the BE priority area beginning in FY 2005 will be research on biocomplexity in aqueous systems. These systems may be at small scales, such as aquatic organisms and their effect on water flow and safety, or at large scales, such as interactions between the climate variability and aquatic ecosystem function and diversity. Processes that occur at interfaces are particularly attractive topics for investigation. For example, surface studies of molecular processes of sediments or ice may elucidate the interplay among microbes, nutrients, and substrate and also enlarge understanding of transport in aqueous environments. Other interfacial regions such as estuaries, coastal zones, and large rivers offer many scientific and engineering challenges. Here, the complex interactions among terrestrial, aquatic, microclimatic, and human systems have important implications for water quantity and quality. Studying the complexity of a river system, for example, may require integrated investigation of natural and physical features as well as the relationships of social groups that place different values on water use.

Biocomplexity in the Environment Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Biological Sciences	26.00	39.86	39.86	0.00	0.00%
Computer and Information Science and Engineering	7.36	8.00	8.00	0.00	0.00%
Engineering	6.00	6.00	6.00	0.00	0.00%
Geosciences	23.00	37.22	37.22	0.00	0.00%
Mathematical and Physical Sciences	5.21	4.70	4.70	0.00	0.00%
Social, Behavioral and Economic Sciences	0.95	2.00	2.00	0.00	0.00%
Office of International Science and Engineering	0.35	0.50	0.50	0.00	0.00%
Office of Polar Programs	1.41	1.55	1.55	0.00	0.00%
Total, Biocomplexity in the Environment	$70.28	$99.83	$99.83	0.00	0.00%

Totals may not add due to rounding.

Long-term Goals: This year NSF will continue to emphasize research and education on the role of Biocomplexity in the Environment. This priority area is part of the investments and accomplishments within NSF's FY 2005 environmental investment portfolio of approximately $1.0 billion. The intellectual goals of the effort are to:

- Synthesize environmental knowledge across disciplines, subsystems, time and space;
- Discover new methods, models, theories, and conceptual and computational strategies for understanding complex environmental systems;
- Develop new tools and innovative applications of new and existing technologies for cross-disciplinary environmental research;
- Integrate human and societal and ecological factors into investigations of the physical environment and environmental engineering;

- Improve science-based forecasting capabilities and enhance research on decision-making and human environmental behaviors; and
- Advance a broad range of infrastructure to support interdisciplinary environmental activities: collaboratory networks, information systems, research platforms, international partnerships, and education activities that enhance and diversify the future environmental workforce.

Long-term Funding for Biocomplexity in the Environment
(Dollars in Millions)

FY 2000 Actual	FY 2001 Actual	FY 2002 Actual	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	FY 2006	FY 2007
$50.00	$54.88	$58.96	$70.28	$99.83	$99.83	$101.83	$103.86

FY 2005 Topical Areas: In FY 2005, NSF plans to invest $99.83 million in the interdisciplinary Biocomplexity in the Environment activities described below. The first two areas listed are relevant to enhanced fundamental understanding of microorganisms important in nature and to humans, including some microbes that are potentially harmful.

- **Microbial Genome Sequencing** – use of high throughput sequencing of microorganisms of fundamental biological interest, importance to agriculture, forestry, food and water quality, or value in understanding potential agents of bioterrorism. Genome sequence information will provide the basis for understanding the physiology, pathology, and ecology of these organisms. This knowledge can be applied to detection and economic uses of organisms and to understanding microbial adaptation to extreme environments. Emphasis will also be placed on sequencing of microbes and their associations with other organisms – plant, animal, and other microbes. This is an interagency activity with the U.S. Department of Agriculture.

- **Ecology of Infectious Diseases** – development of predictive models and discovery of principles for relationships between environmental factors and transmission of infectious agents. Potential benefits include the development of disease transmission models, understanding of unintended health effects of environmental change, and improved prediction of disease outbreaks, emergence, and reemergence. Examples of environmental factors include habitat transformation, biological invasion, biodiversity loss, and contamination. This activity involves an interagency partnership with the National Institutes of Health.

- **Dynamics of Coupled Natural and Human Systems** – quantitative, interdisciplinary analyses of relevant human and natural system processes and the complex interactions among human and natural systems at diverse scales, with special emphasis given to studies of natural capital; landscapes and land use; and uncertainty, resilience, and vulnerability.

- **Coupled Biogeochemical Cycles** – the interrelation of biological, geochemical, geological, and physical processes at all temporal and spatial scales, with particular emphasis on understanding linkages between chemical and physical cycles (for example, the carbon, oxygen, nitrogen, phosphorus and sulfur cycles) and the influence of human and other biotic factors on those cycles.

- **Genome-Enabled Environmental Sciences and Engineering** – the integrated use of genomic and information technology approaches to gain novel insights into environmental questions and problems.
- **Instrumentation Development for Environmental Activities** – the development of instrumentation and software that takes advantage of microelectronics, photonics, telemetry, robotics, sensing systems, modeling, data mining, and analysis techniques to bring recent

laboratory instrumentation advances to bear on the full spectrum of environmental biocomplexity questions.

- **Materials Use: Science, Engineering and Society** – studies directed toward reducing adverse human impact on the total, interactive system of resource use; the design and synthesis of new materials with environmentally benign impacts on biocomplex systems; as well as maximizing the efficient use of individual materials throughout their life cycles.

In addition to these primary areas, other multidisciplinary research and education activities will be supported. These include:

- Water Cycle and Freshwater Resources – complex human, biological, and physical processes that influence water cycle variability, hydrologic reservoirs, and geochemical functions
- Carbon Cycle and Geomicrobiology – research on mediation of carbon distribution, transformation and transport among terrestrial, atmospheric, and ocean environments by biota
- Social and Behavioral Processes – scientific understanding of social and behavioral processes associated with materials use and adaptation to environmental change
- "Tree of Life" – exploration of genealogical relationships of extant species using new algorithmic methods and genomic technologies
- Synthesis – capacity-building activities to support novel partnerships that will integrate knowledge and information about complex environmental systems
- Educational Activities – biocomplexity-oriented projects in workforce development, including underrepresented minorities, and development of science teachers and curricular materials
- International Partnerships - collaborations with research partners in other countries that expand the scope of biocomplexity research activities and broaden the experience of U.S. students

Recent Research Highlight

Urban Trace-gas Emissions Study (UTES): Interactions Among Canopy Processes, Anthropogenic Emissions, and Social Institutions in the Salt Lake Valley, Utah

The majority of greenhouse gases and other atmospheric pollutants originate in cities, generated both by human activities and vegetation. For this reason, it is important to understand the complex social, physical, and biological processes at play in the urban airshed. To study the influences of urban land cover and emissions, an interdisciplinary team of researchers selected the Salt Lake Valley, a region with excellent historical records, an extensive urban forest relative to the surrounding desert ecosystem, and a rapid rate of urban growth. Using the results of atmospheric and energy use measurements, traffic monitoring, and remote sensing, they are developing a quantitative model of this dynamic system. The user-friendly model is being used as a tool to explore the factors affecting air quality and the impact of future scenarios of urban growth. Decision-makers from city, county, and state governments are participating in the project, and a social science team has been assigned to evaluate the effectiveness of the partnership between university researchers and decision-makers. The long-term goal of the project is to evaluate possible ways to reduce

greenhouse gas emissions, maintain high air quality standards, and improve the quality of life of urban residents.

Nanoscale Science and Engineering

The Nanoscale Science and Engineering (NS&E) priority area encompasses the systematic organization, manipulation and control of matter at atomic, molecular and supramolecular levels. Novel materials, devices, and systems – with their building blocks on the scale of nanometers – shift and expand possibilities in science, engineering and technology. A nanometer (one-billionth of a meter) is to an inch what an inch is to 400 miles. With the capacity to manipulate matter at this scale, science, engineering and technology are realizing revolutionary advances, in areas such as individualized pharmaceuticals, new drug delivery systems, more resilient materials and fabrics, catalysts for industry and order-of-magnitude faster computer chips.

Nanoscale science and engineering research promises a better understanding of nature, a new world of products beyond what it is now possible, high efficiency in manufacturing, sustainable development, better healthcare and improved human performance.

Nanoscale Science and Engineering Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Biological Sciences	2.98	5.31	5.85	0.54	10.2%
Computer and Information Science and Engineering	11.14	15.79	19.40	3.61	22.9%
Engineering	94.35	108.88	133.81	24.93	22.9%
Geosciences	7.53	7.94	7.94	0.00	0.0%
Mathematical and Physical Sciences	103.92	111.48	132.14	20.66	18.5%
Social, Behavioral and Economic Sciences	2.32	1.56	1.50	-0.06	-3.8%
Office of International Science and Engineering	N/A	N/A	0.26	0.26	N/A
Subtotal, Research and Related Activities	222.24	250.96	300.90	49.94	19.9%
Education and Human Resources	0.22	2.55	4.16	1.61	63.1%
Total, Nanoscale Science and Engineering	$222.46	$253.51	$305.06	$51.55	20.3%

Totals may not add due to rounding.

The National Nanotechnology Initiative (NNI) began in FY 2001 (http://www.nano.gov). NSF's role in NNI emphasizes long-term, fundamental research aimed at discovering novel phenomena, processes, and tools; addressing NNI Grand Challenges; supporting new interdisciplinary centers and networks of excellence; supporting research infrastructure, including shared user facilities; and addressing research and educational activities on the societal implications of advances in nanoscience and nanotechnology.

NSF has been a pioneer among federal agencies in fostering the development of nanoscale science, engineering and technology. In FY 2004, an estimated $253.51 million supports research in a wide range of research and education activities, including approximately 20 nanotechnology research and education centers, which focus on electronics, biology, optoelectronics, modeling and simulation, advanced materials and engineering.

This investment will expand by 20.3 percent in FY 2005 to $305.06 million to develop and strengthen critical fields (including nanobiotechnology, manufacturing and catalysis at the nanoscale, instrumentation, and education) to further establish the science and engineering infrastructure and a

workforce to exploit opportunities presented by these new capabilities. Support will encompass single investigator research, interdisciplinary research and education teams, national science and engineering centers, exploratory research and education projects, and education and training.

Long-term objectives include building a foundation of fundamental research for understanding and applying novel principles and phenomena for nanoscale manufacturing and other NNI Grand Challenges; ensuring that U.S. institutions have access to a full range of nano-facilities; enabling access to nanotechnology education for the public through informal education, and for students in U.S. middle schools, secondary schools, colleges and universities; and catalyzing the creation of new commercial markets that depend on three-dimensional nanostructures. These goals will enable development of revolutionary technologies that contribute to improved human health, agricultural advancements, material and energy conservation, and sustainability in the environment.

Long-term Funding for Nanoscale Science and Engineering
(Dollars in Millions)

FY 2001 Actual	FY 2002 Actual	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	FY 2006	FY 2007
$149.68	$192.28	$222.46	$253.51	$305.06	$315.00	$325.00

FY 2005 Areas of Emphasis: NSF's five programmatic focus areas are:

- **Fundamental Research and Education.** The FY 2005 Request level includes $174.0 million for fundamental research and education, with special emphasis on:

  - *Biosystems at the Nanoscale* – Approximately $24.5 million to support study of biologically-based or -inspired systems that exhibit novel properties and potential applications. Potential applications include improved drug delivery, biocompatible nanostructured materials for implantation, exploiting of functions of cellular organelles, devices for research in genomics, proteomics and cell biology, and nanoscale sensory systems, such as miniature sensors for early detection of cancer.
  - *Nanoscale Structures, Novel Phenomena and Quantum Control* – Approximately $65.8 million to discover and understand phenomena specific at the nanoscale, including new phenomena in nanoelectronics and advanced silicon technology, create new materials and functional nanoscale structures and to exploit their novel properties. Potential applications include quantum computing and new devices and processes for advanced communications and information technologies.
  - *Device and System Architecture* – Approximately $32.0 million to develop new concepts to understand interactions among nanoscale devices in complex systems, including the physical, chemical, and biological interactions between nanostructures and device components. Interdisciplinary teams will investigate methods for design of systems composed of nanodevices.
  - *Nanoscale Processes in the Environment* – Approximately $11.5 million to support studies on nanoscale physical and chemical processes related to the trapping and release of nutrients and contaminants in the natural environment. Potential benefits include artificial photosynthesis for clean energy and pollution control, and nanoscale environmental sensors and other instrumentation.
  - *Multi-scale, Multi-phenomena Theory, Modeling and Simulation at the Nanoscale* – Approximately $22.2 million to support theory, modeling, large-scale computer simulation and new design tools and infrastructure in order to understand, control and accelerate development in new nanoscale regimes and systems.
  - *Manufacturing Processes at the Nanoscale* - Approximately $14.0 million to support new concepts for high rate synthesis and processing of nanostructures, nanostructured catalysts, fabrication methods for devices, and assembling them into nanosystems and then into larger scale structures of relevance in industry and in the medical field.

- *Converging Technologies from the Nanoscale* – Approximately $4.0 million. The convergence of nanotechnology with information technology, modern biology and social sciences will reinvigorate discoveries and innovation in almost all areas of the economy. This new theme includes investments in:
  - Nano-biology interface and improving human performance; and
  - Nano-information interface research.

- **Grand Challenges.** Approximately $11.9 million will fund interdisciplinary activities to focus on major long-term challenges: nanostructured materials 'by design,' nanoscale electronics, optoelectronics and magnetics, nanoscale-based manufacturing, catalysts, chemical manufacturing, biological-chemical detection and protection, environment and healthcare.

- **Centers and Networks of Excellence.** Approximately $57.5 million will support five new research and education centers with a focus on converging science and technology from the nanoscale, and a multidisciplinary, multi-sectoral network for modeling and simulation at the nanoscale.

- **Research Infrastructure.** Approximately $36.9 million will support instrumentation and facilities for improved measurements, processing and manipulation at nanoscale, and equipment and software for modeling and simulation. University-industry-national laboratory and international collaborations will be encouraged, particularly for costly instrumentation and facilities. Support for the National Nanofabrication Infrastructure Network (NNIN), established in FY 2004, is also included.

- **Societal and Educational Implications of Science and Technology Advances.** Approximately $24.7 million will support student assistantships, fellowships and traineeships, curriculum development on nanoscience and engineering and development of new teaching tools. The implications of nanotechnology on society will be analyzed from social, behavioral, legal, ethical, and economic perspectives. Factors that stimulate scientific discovery at the nanoscale ensure the responsible development of nanotechnology, and converging technologies to improve human performance will be investigated. The development and use of nanoscale technologies is likely to change the design, production and use of many goods and services, ranging from vaccines to computers to automobile tires.

FY 2005 will likely see accelerated transition from scientific discoveries to technological innovation, due to the increased rate of discoveries over the past several years. Funding priority will be given to: (1) research enabling the nanoscale as the most efficient manufacturing domain including fabrication of nanostructured materials, nanosystems and nanoscale catalysis, (2) nanobiotechnology, and nanobiology for improving human performance, (3) innovative nanotechnology solutions to biological-chemical-radiological-explosive detection and protection, (4) discovery, understanding and potential application of phenomena specific to the nanoscale, (5) development of new instrumentation and standards, and in particular for imaging, characterization and manipulation of materials and systems in three dimensions at the nanoscale, (6) education and training of a new generation for future industries, including high school, undergraduate, graduate and informal education through the Nanoscale Science and Engineering Education program solicitation, and (7) the National Nanotechnology Infrastructure Network (NNIN) for user facilities, development of new instrumentation, and training.

Program Assessment Rating Tool (PART) Evaluation: A PART on the Nanoscale Science and Engineering (NS&E) priority area was completed to inform the FY 2005 budget decision-making process. Overall, the PART assessment found NS&E to be an "effective" program. With respect to program purpose and design, the PART review found that the program's purpose, to "support fundamental knowledge creation across disciplinary principles, phenomena, and tools at the nanoscale, and to catalyze

synergistic science and engineering research and education in emerging areas of nanoscale science and technology," is clear. The program addresses the need to develop a knowledge base, workforce and infrastructure to advance nanotechnology. The program relies on the competitive merit review process, an NSF working group that has representation from each participating directorate, Program Officers in their oversight capacity, and independent reviews by external entities such as the National Research Council to provide scrutiny of the program goals, ensuring effectiveness and efficiency.

With respect to strategic planning, the program was found to have a limited number of long-term performance measures with ambitious targets and timeframes that promote continuous improvement. These encompass development of a capable interdisciplinary research community, provision of the necessary research infrastructure, development of educational curricula, and building a knowledge base that enables the next industrial revolution. NS&E has annual performance measures that provide confidence that the program is moving toward accomplishment of its long-term goals. Evaluations are conducted regularly in order to inform program improvements and influence program planning. The National Nanotechnology Initiative (NNI) as a whole has been comprehensively evaluated by the National Research Council and will continue to receive annual evaluation. An NS&E-wide Committee of Visitors (COV) is planned for FY 2004. Performance information is incorporated into NSF's budget decisions and NSF's budget requests to the Congress. The budget also clearly presents the resource request for each program and outlines the activities that will be supported with the funds.

With respect to program management, NS&E was found to collect timely and credible performance information and to use it to manage the program and improve performance. NS&E grant recipients are required to submit annual and final project reports. NSF program managers conduct site visits and NS&E awards are included in COV reviews. Quantitative goals are monitored based on data in NSF's corporate systems. NS&E was also found to effectively coordinate and collaborate with related programs, use strong financial management processes and obligate funds in a timely manner. In order to assure sufficient knowledge of grantee activities, among other mechanisms, NS&E conducts an annual grantees workshop to highlight major accomplishments.

To a large extent, NS&E has demonstrated adequate progress in achieving its long-term goals. A number of important discoveries and their applications of nanoscale materials and devices that are impacting the economy or close to commercialization can be tied to NNI, for which NSF plays the lead federal role. NSF's participation is pivotal to the success of the overall NNI program goals. NS&E is a relatively young, robust priority area at NSF, for which internal assessment tools (such as the NS&E-wide COV) are under development. Contributing theme elements, such as nanomanufacturing, Materials Research Science and Engineering Centers and Nanoscale Science and Engineering Centers, are evaluated periodically by COVs. The complete PART for Nanoscale Science and Engineering and other assessed NSF programs may be found on the OMB Website.

FY 2005 Annual Performance Goal – Award Size: The average annualized new research grant award size funded via the NS&E solicitation will be at least $330,000.

Average annualized award size for research grants funded via the NS&E solicitation					
	FY 2001	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**
Goal			$330,000	$330,000	$330,000
Result	$363,000	$323,000	$315,000	&	&

& = Data not yet available

An average annualized award size of $330,000 is an ambitious target; significantly greater than NSF's FY 2003 average annualized award size of $136,000, and even larger than NSF's long-term goal of $250,000.

Means and Strategies for Success:

- Use electronic monitoring systems to keep track of average award size and duration and to modify funding strategies as needed.
- Communicate with the research and education community about the proposal duration and budget size using the dedicated NSE websites and professional meetings.

Resources Required: This goal can be achieved with the resources requested in FY 2005.

FY 2005 Annual Performance Goal – Access to Infrastructure – At least four thousand users will access National Nanofabrication Users Network/National Nanotechnology Infrastructure Network (NNUN/NNIN) and Network for Computational Nanotechnology (NCN) sites.

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007
Goal			3,000	4,000	4,000	4,500	5,000
Result	1,300	1,700	3,000	&	&	&	&

& = Data not yet available.

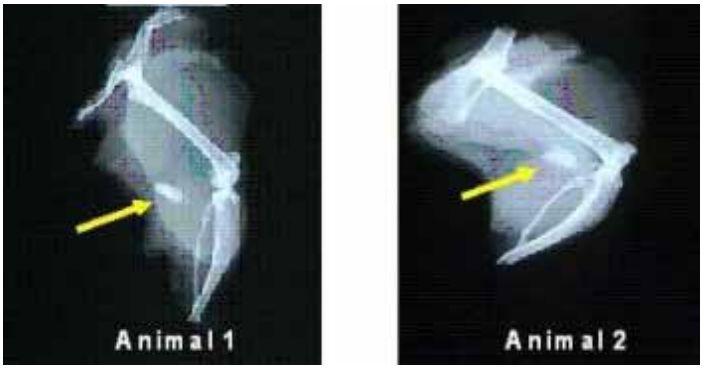
Means and Strategies for Success:

- Expand the number of involved universities and other partners within the networks.
- Offer long-distance education programs and remote use of facilities.
- Conduct annual reviews of the research and education topics to address national needs.

Resources Required: This goal can be achieved with the resources requested in FY 2005.

Recent Research Highlight

Ink-Jet Production of Nanostructured Matrices and Particles for Controlled Gene Delivery.
Gene therapy has great potential in engineering new tissue to replace defective organs and tissue while also being useful for the treatment of many genetically transferred diseases such as muscular dystrophy and cystic fibrosis. Gene delivery now uses viral therapy, where a virus is used to insert a gene into a target cell. This approach carries the risk of unknown diseases being transferred or the possibility of cancerous mutations associated with the manipulation of the virus to deactivate its active forms. Non-viral gene delivery may avoid many of these risks.



X-ray images of two animal subjects in which the nanoscopic DNA carriers have demonstrated bone formation at a muscle site.

A research group at Carnegie Mellon University and the University of Pittsburgh has demonstrated a mechanical method of introducing genes using ceramic particles that carry non-viral DNA. They have synthesized nanosize particles that have been incorporated into a matrix composed of materials that are naturally found in the body, to ensure compatibility. One such material is calcium phosphate – a material found in the bones – and the other is fibrin-a biopolymer that is involved in clotting as part of the body's

wound-healing response. A fibrin matrix containing calcium phosphate nanoparticles with bone-forming DNA has been inserted into the tissue of laboratory rats. This matrix has been demonstrated to promote bone formation where there previously was no bone.

Small drops containing the DNA-particle complex and matrix material are deposited in layers inside the body in locations where bone is missing. Ink jet printing makes it possible to create unique three-dimensional shapes, tailoring the matrices (scaffolds for bone growth) to the desired bone reconstruction within the organism. This automated technique could enable large-scale commercialization of controlled gene delivery once the robotic ink jet printing technique has been fully developed. This could lead to significantly improved bone reconstruction therapy and possibly enhanced therapy to repair other tissues as well.

Mathematical Sciences

Today's discoveries in science, engineering and technology are intertwined with advances across the mathematical sciences. New mathematical tools disentangle the complex processes that drive the climate system; mathematics illuminates the interaction of magnetic fields and fluid flows in the hot plasmas within stars; and mathematical modeling plays a key role in research on micro-, nano-, and optical devices. Innovative optimization methods form the core of computational algorithms that provide decision-making tools for Internet-based business information systems.

The fundamental mathematical sciences – embracing mathematics and statistics – are essential not only for the progress of research across disciplines, they are also critical to training a mathematically literate workforce for the future. Technology-based industries that help fuel the growth of the U.S. economy and increasing dependence on computer control systems, electronic data management, and business forecasting models, demand a workforce with effective mathematical and statistical skills, well-versed in science and engineering.

It is vital for mathematicians and statisticians to collaborate with engineers and scientists to extend the frontiers of discovery where science and mathematics meet, both in research and in educating a new generation for careers in academia, industry, and government. For the United States to remain competitive among other nations with strong traditions in mathematical sciences education, we must attract more young Americans to careers in the mathematical sciences. These efforts are essential for the continued health of the nation's science and engineering enterprise.

The role of mathematics has expanded in science and society, but the nation’s scientific, technical, and commercial enterprises depend on three key areas: fundamental mathematical and statistical research, interdisciplinary collaboration between the mathematical sciences and other disciplines, and mathematics education. To strengthen the mathematical foundations of science and society, the NSF will continue to support the priority area, focused on the mathematical sciences, encompassing interdisciplinary efforts in all areas of science, engineering, and education supported by the Foundation.

Mathematical Sciences Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Biological Sciences	0.91	2.21	2.21	0.00	0.0%
Computer and Information Science and Engineering	2.29	2.29	2.29	0.00	0.0%
Engineering	0.91	2.91	2.91	0.00	0.0%
Geosciences	4.57	7.07	7.07	0.00	0.0%
Mathematical and Physical Sciences	47.39	70.19	70.19	0.00	0.0%
Social, Behavioral and Economic Sciences	1.43	1.50	1.50	0.00	0.0%
Office of Polar Programs	0.18	0.18	0.20	0.02	11.1%
Subtotal, Research and Related Activities	$57.68	$86.35	$86.37	0.02	0.0%
Education and Human Resources	$2.74	$2.74	$2.74	0.00	0.0%
Total, Mathematical Sciences	$60.42	$89.09	$89.11	$0.02	0.0%

Totals may not add due to rounding.

Long-term Goals: The goal of this priority area is to advance frontiers in three interlinked areas: (1) fundamental mathematical and statistical sciences, (2) interdisciplinary research involving the mathematical sciences with science and engineering, and focusing on selected themes, and (3) critical investments in mathematical sciences education. The investment plan (FY 2002 – FY 2007) will allow efforts in research and education to take root and begin a transformation in the way mathematics, science, and education interact. The long-term goals of the investments in the priority area are to:

- Foster significant advances in fundamental mathematics and statistics with important benefits for the mathematical and other sciences and engineering;
- Bring support for researchers in the mathematical sciences to a level competitive with other sciences and recognize mathematicians and statisticians as full partners in research, by increasing award size and duration;
- Integrate the most appropriate, state-of-the-art, statistical principles and mathematical tools and concepts into all NSF sponsored research;
- Foster interdisciplinary research partnerships that integrate the mathematical sciences with other science and engineering disciplines;
- Train a new generation of researchers in interdisciplinary approaches to future science and engineering challenges;
- Increase the numbers and diversity of U.S. students trained in the mathematical and statistical sciences to meet the increasing demands of scientific research, engineering, and technology in academic institutions, industry, and government laboratories; and
- Develop a framework to significantly advance the image and understanding of mathematics in the general population.

Long-term funding for the Mathematical Sciences
(Dollars in Millions)

FY 2002 Actual	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	FY 2006	FY 2007
$30.00	$60.42	$89.09	$89.11	$90.00	$92.00

FY 2005 Areas of Emphasis: NSF plans to invest $89.11 million in the Mathematical Sciences activities described below.

- **Fundamental Mathematical and Statistical Sciences:** Fundamental research areas include themes such as dynamical systems and partial differential equations, geometry and topology, stochasticity, number theory, algebraic and quantum structures, the mathematics of computation, statistics, and multi-scale and multi-resolution analysis. To enhance research in these areas, the NSF will provide improved support for mathematical sciences through research groups and individual investigator grants, as well as through institute and undergraduate, graduate, and postdoctoral training activities.

- **Advancing Interdisciplinary Science and Engineering:** The concepts and structures developed by fundamental mathematics often provide just the right framework for the formulation and study of applications in other disciplines. Mathematics and statistics have yielded new analytical, statistical, computational, and experimental tools to tackle a broad range of scientific and technological challenges long considered intractable. This success has fueled a demand both for further development of new mathematical and statistical techniques and for research teams capable of applying these sophisticated techniques to the problems of science and engineering. A new breed of researchers, broadly trained in both mathematics and science or engineering disciplines, is needed to tackle the increasingly complex multidisciplinary research topics that confront society. Three broad, interdisciplinary research themes are being emphasized in the mathematical sciences priority area:

  - **Mathematical and statistical challenges posed by large data sets** – Much of modern science and engineering involves working with enormous data sets. Major challenges include: the identification and recovery of meaningful relationships between data; the identification and validation of the structure of large data sets, which require novel mathematical and statistical methods; and improvement of theories of control and decision-making based on large data streams, with new statistical techniques to assess complicated data sets. These challenges arise in such diverse arenas as: large genetic databases; the explosion of data gathered from satellite observation systems, seismic networks, and global oceanic and atmospheric observational networks; situations in which privacy and missing data are major concerns; the massive data streams generated by automated physical science instruments, which must be compressed, stored and accessed for analysis; and data produced by modern engineering systems that place networked sensors and actuators on scalable networks to support dynamic interactions.

  - **Managing and modeling uncertainty** – Predictions and forecasts of phenomena – bracketed by measures of uncertainty – are critical for making better decisions, whether in public policy or in research. Improved methods for assessing uncertainty will increase the utility of models across the sciences and engineering and result in better predictions of phenomena. Improving the ability to forecast extreme or singular events will improve safety and reliability in such systems as power grids, the Internet, and air traffic control. Advancing techniques to assess uncertainty has applications ranging from forecasting the spread of an invasive species, to predicting genetic change and evaluating the likelihood of complex climate change scenarios. In the social sciences, methods for assessing uncertainty will improve the utility of forecasts of market behavior.

  - **Modeling complex nonlinear systems** – Advances in mathematics are necessary for a fundamental understanding of the mechanisms underlying interacting complex systems and will be essential to the further development of modern physical theories of the structure of the universe at the smallest and largest scales. Across the sciences, there is a great need to analyze and predict emergent complex properties and understand multi-scale phenomena, from social behaviors to brain function, and from communication networks to multi-scale business information systems to complex engineering systems. The development of new mathematical and statistical ideas and tools for understanding complex systems in the environment will be a particular area of interest, building on efforts initiated in FY 2004.

To enhance research in these areas of science and engineering, which depend on cross-cutting themes in the mathematical sciences, NSF support will build on existing efforts and create new opportunities to encompass interdisciplinary research groups, interdisciplinary centers, interdisciplinary cross-training programs, and partnership activities with other federal agencies. Training activities will cover interdisciplinary professional development at many levels and those that link highly innovative training activities with research. International activities, especially those involving students, will be included.

- **Advancing Mathematical Sciences Education:** This effort will support innovative educational activities, centered on the research priorities highlighted above. Activities which foster closer connections between research and education will include: curriculum development both in the mathematical sciences and in incorporating sophisticated mathematics into other disciplines; introducing new ideas across the K-16 spectrum; and research on how mathematics is learned, particularly in light of new learning technologies and emerging mathematical fields. Investments include support for undergraduate and graduate education and postdoctoral training coupled with curriculum reform. One particular emphasis will be to enhance undergraduate research experiences at the interface between the mathematical sciences and other science and technical disciplines, building on activities between the mathematical and biological sciences initiated in FY 2003 and continued in FY 2004.

Recent Research Highlight

Transport Processes in Geophysical Systems.
The exchange of heat, gases, and fluids between the ocean and atmosphere through the sea ice packs are among the most fundamental processes driving the earth's climate and polar biological activity. However, little is known about the effective fluid and transport properties of sea ice, a porous composite material. Researchers at the University of Utah, supported through NSF's Collaborations in the Mathematical Geosciences competition, together with a collaborator at the University of Alaska, are developing new theories for the fluid permeability of sea ice and for effective thermal transport through sea ice, as well as modeling life sustaining, diffusive processes in the brine microstructure, necessary for the survival and growth of sea ice bacterial populations. In particular, progress has been made in seeing how different length scales interact in different situations and how theory, field, and laboratory work are inter-related. This project has a significant component of undergraduate research, involving three students who have engaged in field and laboratory work on Arctic sea ice.

Human and Social Dynamics

The twentieth century saw an unprecedented growth in our understanding of the physical and biological worlds. New technologies transformed everyday life and enabled the development of a more closely linked global economy. Our understanding of human and social functioning, however, has not kept pace. The arrival of the twenty-first century has brought with it new hopes and possibilities for better living, but also change, uncertainty and disruption.

Research into human and social phenomena is increasingly characterized by a focus on "dynamics," that is on how the behavior of individuals, formal and informal organizations, and societies evolve and changes over time. New methods, data and technologies have invigorated the social and behavioral sciences, as have findings in other disciplines. Today, scientific understanding of the dynamics of

individual behavior and social activity increasingly builds on partnerships that span the scientific and engineering communities. For example, the convergence of research in biology, engineering, nanotechnology, information technology, and cognitive science is crucial for understanding the dynamics of mind, brain and behavior and also offers new possibilities for studying group and organizational behavior. Geographic information systems (GIS) and other technologies, together with mathematically rooted advances in multilevel modeling and network analysis, have opened new frontiers for understanding such diverse subjects as crime, environmental management, epidemics and patterns of linguistic behavior.

We know that social and knowledge systems do not develop independently. Humans develop new knowledge that leads to new technologies. Social institutions shape what knowledge is produced and influence new markets and products. Because people and institutions respond to and are influenced by new knowledge and technologies, understanding the human and social dynamics underlying these complex interdependencies is essential for our nation's progress and well-being. Multi-scaled, multi-disciplinary approaches, many of which have been made possible by recently acquired knowledge and new technologies, provide the tools and techniques needed to expand necessary understanding. The NSF priority area, *Human and Social Dynamics* (HSD), develops and applies these and other approaches.

Human and Social Dynamics Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Biological Sciences		0.50	0.50	0.00	0.0%
Computer and Information Science and Engineering		3.00	3.00	0.00	0.0%
Engineering		2.00	2.00	0.00	0.0%
Geosciences		1.35	1.35	0.00	0.0%
Mathematical and Physical Sciences		0.50	0.50	0.00	0.0%
Social, Behavioral and Economic Sciences	4.46	15.90	15.90	0.00	0.0%
Subtotal, Research and Related Activities	$4.46	$23.25	$23.25	0.00	0.0%
Education and Human Resources		$0.99	$0.00	-0.99	-100.0%
Total, Human and Social Dynamics	$4.46	$24.24	$23.25	-$0.99	-4.1%

Totals may not add due to rounding.

Long-term Goals: This priority area began in FY 2003 and will continue for a period of five years. In the FY 2004 Budget Request to Congress, NSF emphasized research and education related to *Human and Social Dynamics*. The intellectual goals of the effort are to:

- Exploit the convergence in biology, engineering, information technology and cognition to advance our understanding of human behavior and performance at the individual, social, and population levels;

- Refine our knowledge of decision-making, risk, and uncertainty, and to learn how to translate this knowledge into improved decision-making and risk communication;

- Develop a comprehensive, multi-disciplinary approach to understanding human and social dynamics, incorporating international, regional, and cross-cultural approaches;

- Create accessible large-scale data resources and advance methodological frontiers. Areas ripe for progress include: agent-based modeling, complex network analysis, non-linear dynamics,

computer-assisted qualitative analysis, and multi-level, multi-scalar analysis and measurement research and technologies. Advances in these areas will provide the foundation for social and behavioral investigations for the next decade or more, and will create spillover effects that extend beyond the social sciences;

- Develop the broad range of infrastructure needed to support transformative interdisciplinary research. Examples include collaboratory research networks, large-scale data repositories and experimental laboratories, cognitive neuroimaging centers, national and international topic-focused research sites, and innovative research platforms such as real and modeled virtual communities and intelligent environments.

Long-term Funding for Human and Social Dynamics
(Dollars in Millions)

FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	FY 2006	FY 2007	FY 2008
$4.46	$24.24	$23.25	$25.00	$30.00	$35.00

FY 2005 Areas of Emphasis: In FY 2005, NSF plans to invest $23.25 million in interdisciplinary research on *Human and Social Dynamics* with special attention to the priorities described below.

Agents of change – Research will focus on better understanding of large-scale transformations, such as globalization and democratization, and the role of education as an agent of change; the reciprocal relationship between individual and social action; the evolution of society and its interaction with climate, geography and environment; the implications of cultural change and variation for intergroup relations, including conflict, assimilation, diversity, and equality; and impacts, adaptation, and resistance to technological change and new science-based knowledge.

Dynamics of human behavior – Work in this area will support innovative research on cognitive, linguistic, developmental, social, organizational, cultural, biological and other processes essential to understanding individual and group behavior as structured phenomena that develop and change over time. This area of emphasis aims to stimulate research using state-of-the-art methods and cross-disciplinary approaches to better understand the dynamic processes that shape human behavior and action. Research might, for example, exploit the convergence in nanotechnology, biotechnology, information technology, and cognitive neuroscience to better understand the development of human communication. Other examples of relevant research are investigations into the cognitive requisites for effective human-machine interfaces and studies of the robustness of organizational forms to unexpected exogenous shocks. Support will also be available for educational activities related to the development and use of innovative approaches, tools and techniques.

Decision-making under uncertainty – Research will focus on decision-making in normal and crisis circumstances, the implications of distributed versus centralized decision-making systems; new approaches to risk analysis including risk assessment and risk management; and the development of databases, decision-support systems, and other tools and approaches to facilitate effective decision-making and risk communication. Especially important will be research on behavior in response to extreme events such as natural disasters and terrorist attacks. Approximately $5.0 million within the SBE Directorate supports a portion of NSF's $25.0 million investment in the Administration's Climate Change Research Initiative.

Spatial social science – Recent technological advances have the potential for qualitatively changing the nature of social science by providing tools and techniques for acquiring information about location that

can be combined with demographic, political, health-related and other social data. Examples of such advances hold great promise for all facets of society and include the use of Global Positioning Systems for highly precise locational specification; the use of mobile devices, integrated sensors/transmitters; and the design of intelligent environments for information access and transmission. Investments in this area will lead to improvements in existing tools and technologies and will help to make them more accessible. Research in this area will use these and other technologies to explore and map the spatial aspects of human and social dynamics, including: neighborhood effects on social outcomes; the growth of virtual, regional, and global networks that defy traditional geographic and spatial boundaries; the geo-spatial dimensions of innovation and knowledge spillovers; and environmental spatial history, where studies of environmental history inform us about how humans have interacted with the natural landscape.

Modeling human and social dynamics – Research foci will include: (1) complex networks, such as social groups, large organizations, electrical distribution grids, and economic and cognitive systems across time and space, (2) the integration of formal modeling and empirical testing, and (3) group and societal behavior as a result of numerous individual, small group, or micro-cultural actions and decisions. Promising lines of inquiry include: stochastic agent-based modeling, social network analysis, multi-level models, non-linear dynamics, and the use of innovative information and engineering technologies in modeling human interaction and behavior.

Instrumentation and data resource development – The development of instrumentation and software that takes advantage of information technology, microelectronics, nanotechnology, photonics, robotics, sensing systems, modeling, data mining, and meta-analysis techniques promises to bring recent laboratory instrumentation advances to bear on the full spectrum of social and behavioral questions. New instruments include tools and techniques for genetic analysis and cognitive neuroimaging. Data resource needs include new and extended longitudinal databases such as those that capture organizational variables and changes in them over time. Tools are also needed for data-rich linguistic analysis and corpus linguistics, and databases with fail-safe privacy protections, that couple genetic information with behavioral and social information. Database related tools include systems and devices for more rigorously collecting and analyzing qualitative data; the integration of diverse data resources across multiple scales; advanced techniques for the analysis of information from diverse sources; and technologies for anonymizing sensitive data and efficiently analyzing these data.

Workforce for the 21st Century

The nation's economic vitality, security, and quality of life depend on a workforce that is scientifically and technologically literate and a science and engineering professional workforce that is world class at all levels. Our educational system has been and continues to be effective at the collegiate level and attracts those students globally. However, many K-12 graduates are ill-prepared to respond to the demands of today's world, fewer young Americans choose to pursue science and engineering careers, and fewer than half of those who do choose these career paths graduate, putting the nation's economy and security at peril.

This softening of the nation's science and engineering capacity is exacerbated by the slow progress in attracting, supporting, developing, and advancing underrepresented minorities, women and persons with disabilities to careers in science and engineering. This shortcoming must be overcome with both passion and strategic investment. It is unrealistic to imagine that the United States can persist in sustaining its freedom without long-term dedication to resolving this workforce conundrum. In the words of James Madison, "What spectacle can be more edifying or more seasonable than that of liberty and learning, each leaning on the other for their mutual and surest support?"

NSF's *Workforce for the 21st Century* priority investment will capitalize on its experience with programmatic investments made over the years by integrating the most effective of them; premising program designs on research findings bearing on science, technology, engineering, and mathematics learning; and broadening participation throughout. The objective is a highly synergistic and interconnected enterprise requiring active involvement of researchers and educators at all levels and from every science and engineering discipline.

NSF has a long tradition of innovation in science, technology, engineering, and mathematics education. From its initial 1952 investment in Graduate Research Fellowships (a story on the Class of '52 is posted at http://www.nsf.gov/od/lpa/nsf50/classof52.htm) to K-12 curriculum and faculty development to television programming for the public, NSF has promoted the preparation of high quality scientists and engineers, and scientifically literate citizens. Now, in the *Workforce for the 21st Century (Workforce 21)* priority area, these efforts will be brought together in distinct activities that build on what has been learned over half a century.

Workforce for the 21st Century Funding
(Dollars in Millions)

	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Computer and Information Science and Engineering	0.00	2.56	2.56	N/A
Engineering	0.00	1.03	1.03	N/A
Mathematical and Physical Sciences	0.00	1.03	1.03	N/A
Subtotal, Research and Related Activities	0.00	4.62	4.62	N/A
Education and Human Resources	0.00	15.38	15.38	N/A
Total, Workforce for the 21st Century	$0.00	$20.00	$20.00	N/A

Totals may not add due to rounding.

Long-term goal: For the next five years, all NSF directorates will partner in an integrated research and education effort to address science and engineering workforce needs. The elements of this goal are to:

- Prepare scientists, mathematicians, engineers, technologists and educators capable of meeting the challenges of the 21st Century;
- Attract more U.S. students to science and engineering fields; and
- Broaden participation in science and engineering fields.

To ensure quality of the process and achieve this goal, the following strategies will be pursued:

- Prepare and support K-12 teachers and higher education faculty who inspire and challenge students and provide this instructional workforce with effective materials, training, and methods to promote and assess learners;
- Integrate the linkages of elementary, middle, and high school and the transition to postsecondary education for a seamless K-12 experience for all learners;
- Improve coordination and vertical integration of NSF programs along career paths to ensure an educational pathway for all students;
- Focus on models that attract and retain U.S. students in science and engineering through the junctures along their career paths, from high school to college, from 2-year to 4-year institutions, from baccalaureate to graduate programs (both integrative master's degrees and doctoral research programs), and from graduate study to careers;
- Promote both institutional and multi-institutional networking, partnerships, alliances and collaborations, to achieve results of mutual benefit;

- Pursue research on those factors that influence career choices and evaluate the productivity of strategies for increasing and broadening participation in K-12 science and mathematics and careers in science and engineering; and
- Ensure individual and institutional participation in the nation's nascent cyberinfrastructure.

To achieve the goal of this priority area, three integrative investments that build on successful activities will be pursued over the next five years:

- **Integrative Institutional Collaborations:** Currently, NSF supports a number of effective programs designed to encourage U.S. students to participate in science and engineering fields, ranging from pre-college to postdoctoral study. NSF's investment in K-12 programs rests on attracting U.S. students to these fields in their early years; in addition, collaborations between K-12 and higher education promote alignment of secondary school and higher education by implementation of enriched mathematics and science curricula, and laboratory improvements. Institutions participating in the Louis Stokes Alliances for Minority Participation (LSAMP) program produce 70 percent of the underrepresented minority science and engineering baccalaureate degree recipients. The successful Research Experiences for Undergraduates (REU) investment impacts students across all sectors; REU awards support to individual investigators and site directors offer hands-on research experiences for undergraduates. The Alliances for Graduate Education and the Professoriate (AGEP) program has yielded a substantial increase in minority students earning graduate degrees and this was achieved in just a few years. Centers of Research Excellence in Science and Technology (CREST) develop research capacity in minority-serving institutions.

  Together, these programs advance pre-college students, undergraduates, and graduate students, and build research capacity. When coupled with support for Minority Serving Institutions (MSIs) and Graduate Teaching Fellowships in K-12 Education (GK-12), Major Research Instrumentation (MRI), NSF's investment in cyberinfrastructure to speed the connectivity of everyone to learning and research tools, and other programs, integrated sets of these capacity-building programs can have substantial impact within a campus and, more broadly, on advancement of U.S. students, over and above what is envisioned by any one of them alone. Additionally, NSF's outstanding research and education centers, such as the Science and Technology Centers, the Engineering Research Centers, the Centers for Learning and Teaching, and the Long-Term Ecological Research Program, can be important contributors to campus programs that encompass these many individual programs. Integrative Institutional Collaborations will enable institutions to craft activities that weave together, vertically integrate, and augment support for existing programs, thereby creating a seamless route of advancement for students from the K-12 through post-doctoral levels and beyond – a result that is greater than the sum of its parts.

- **Faculty for the Future.** This program is designed to enhance both preparation and professional development of K-12 teachers and the professoriate. Importantly, it is aimed at offering both K-12 and higher education faculty the opportunity to hone their skills to meet the challenges of today's fast-paced growth in knowledge and tools of knowledge transfer. One component supports development of innovative approaches to educating new K-12 and higher education faculty, i.e., the next generation of teachers, especially those teachers who will attract and retain members of underrepresented groups. These efforts may include development of new cost-effective tools to enhance learning, allow students and faculty to participate in research, including simulation and Internet access to specialized research environments, and to adapt research equipment to educational uses. A second component provides early and mid-career Minority Serving Institution (MSI) faculty with research-based faculty development opportunities in laboratories at research-intensive universities. The intent is to promote mutual partnerships and mentorships between host and visiting

faculty members and to establish long-term relationships between individual faculty members, departments, and institutions in order to strengthen learning-through-research at MSIs.

- **Workforce Research**. As the educational environment increases in complexity, young people and adults have many options in the pursuit of a degree or for enhancing their employability and opportunity for advancement. While many programs and activities elicit interest in science and engineering, it is important to reinforce decisions to pursue careers in those fields. The decisive factors in career choices unfortunately remain elusive. Therefore, research is needed to determine what experiences, strategies, or practices are most effective in attracting and retaining students in careers that require fluency in mathematics, science, engineering, or technology. This program will complement the Centers for Learning and Teaching in promoting study of factors influencing career choices; analyzing the quality and productivity of the pathways that students use to prepare for science and engineering careers or advance in their careers; and evaluating programs designed to increase and broaden participation in science, mathematics, and engineering areas at all levels. The long-term outcome is to develop effective ways to meet the changing needs of the 21st Century workforce for knowledge and skills in science, technology, and engineering.

Long-term Funding for Workforce for the 21st Century
(Dollars in Millions)

FY 2004 Estimate	FY 2005 Request	FY 2006	FY 2007	FY 2008	FY 2009
$0.00	$20.00	$22.00	$25.00	$30.00	$35.00

FY 2005 Investment: In FY 2005, NSF will begin investment in two of the three integrative investments. Integrative Institutional Collaborations will be supported at $13.43 million and Workforce Research to understand and scientifically validate practices that are deemed effective in attracting and retaining students in careers requiring mathematics and science fluency will be supported at $6.57 million.

Information Technology Research

Information Technology Research Funding
(Dollars in Millions)

	FY 2000 Actual	FY 2001 Actual	FY 2002 Actual	FY 2003 Actual	FY 2004 Estimate
Biological Sciences		5.19	6.08	6.80	7.50
Computer and Information Science and Engineering	90.00	155.48	173.51	215.17	218.11
Engineering		8.17	10.23	11.17	11.17
Geosciences		10.90	12.16	13.21	14.56
Mathematical and Physical Sciences		29.62	32.66	35.52	35.52
Social, Behavioral and Economic Sciences		3.82	4.36	4.60	5.15
Office of Polar Programs		1.09	1.22	1.33	1.55
Subtotal, Research and Related Activities	90.00	214.27	240.22	287.80	293.56
Education and Human Resources		2.00	2.00	2.48	9.53
Major Research Equipment and Facilities Construction	36.00	44.90	35.00	44.83	9.94
Total, Information Technology Research	$126.00	$261.17	$277.22	$335.11	$313.03

Totals may not add due to rounding.

From FY 2000 – FY 2004 NSF provided support for the Information Technology Research priority area. Information Technology (IT) has created unprecedented new possibilities for advancing knowledge across the spectrum of human endeavors, including fundamental scientific research, education, engineering design and manufacturing, environmental systems, health care, business, entertainment, and government operations. IT is essential in the growth of our economy and in solving critical problems facing our nation. NSF-supported research extends the frontiers of IT, improves our understanding of IT and its impacts on society, and helps prepare Americans for the Information Age. ITR has also supported Terascale computing investments that are providing state-of-the-art supercomputing resources to U.S. researchers and moving in new directions such as the Extensible Terascale Facility to prepare for cyberinfrastructure investment.

In FY 2000, the NSF Information Technology Research (ITR) program stressed fundamental research and education; in FY 2001, applications in science were added; in FY 2002, the program supported research to create and utilize cutting-edge cyberinfrastructure, enabling research and education in multidisciplinary areas and focusing on emerging opportunities at the interfaces between information technologies and other disciplines. In FY 2003, the ITR program continued its emphasis on interdisciplinary research opportunities, with the intent to stimulate broad research on the fundamental challenges facing the expansion and utilization of IT across science and engineering. In FY 2004, ITR continues to exploit and deepen the ongoing research and continues to expand research in multidisciplinary areas, focusing on fundamental research that will lead to novel and profound insights about our physical, biological, and social world. It continues to support research to enable the wide and secure deployment of pervasive IT through new classes of ubiquitous applications, the creation of new paradigms to achieve high-levels of trust in cyberspace, and the development of new tools and methods to enhance our national security and critical infrastructure protection. NSF priority areas tend to last no more than five years, in order to allow new priority areas to emerge. Consistent with this policy, the ITR priority area is being transitioned back into NSF's fundamental science and engineering core in FY 2005.

Program Assessment Rating Tool (PART) Evaluation: A Program Assessment Rating Tool (PART) on the Information Technology Research (ITR) priority area was completed to inform the FY 2005 budget decision-making process. Overall, the PART assessment found ITR to be an "effective" program. With respect to program purpose and design, the PART review found that the program has a clear

purpose. It responds to the President's Information Technology Advisory Committee (PITAC) Report of 1999 that recommended increased research on software, scalable information infrastructure, high-end computing and the socioeconomic impacts of IT, including IT workforce issues. PITAC also called for "acquisition of the most powerful high end computing systems to support science and engineering research." ITR supports long-term, basic, high-risk research in IT of the kind that is too speculative for industry to support. ITR relies on the competitive merit review process and NSF Program Officers to ensure program effectiveness and efficiency. A Committee of Visitors (COV) for ITR will also be convened to review the program.

With respect to strategic planning, the program was found to have a limited number of long-term and annual performance measures, with ambitious targets and timeframes that promote continuous improvement. Long-term measures have been chosen consonant with the PITAC recommendations and with other NSF performance measures to assure that the program is effective in terms of its own goals and its performance can be judged and compared to that of other NSF programs. Short-term goals provide evidence for long-term evaluation. The ITR program intends to make progress toward its long-term goals and to achieve substantial impact on the nation's IT capabilities and IT workforce by 2008. Performance information is incorporated into NSF's budget decisions and NSF's budget requests to the Congress. The budget also clearly presents the resources requested for each program and outlines the activities that will be supported with the funds.

With respect to program management, ITR was found to collect timely and credible performance information and to use it to manage the program and improve performance. Performance information is collected via interim, annual and final project reports as well as site visits to larger projects. COV reviews and recommendations are utilized to improve program performance. Process-related goals such as dwell time can be monitored via the agency's Enterprise Information System (EIS). ITR was also found to effectively coordinate and collaborate with related programs. ITR coordinates with programs in other agencies through the Interagency Working Group (IWG) on Information Technology Research and Development (ITR&D), which has six interagency "Coordinating Groups" for different aspects of the Networking and ITR&D (NITRD) Program. ITR was found to use strong financial management processes and obligate funds in a timely manner.

To a large extent, ITR has demonstrated adequate progress in achieving its long-term goals. The ITR program has stimulated a high level of research activity and resulted in the initiation of new research directions, institution of new interdisciplinary activities, and expansion of research communities. The FY 2002 Advisory Committee for GPRA Performance Assessment (AC/GPA) assessed ITR as an Area of Emphasis in NSF and reported that "The quality, creativity, importance and breadth of the projects in the ITR Emphasis Area are impressive...The portfolio demonstrates a good balance of risky, high potential benefit projects versus less risky research. Many of the projects are multidisciplinary." The complete PART for Information Technology Research and other assessed NSF programs may be found on the OMB website.

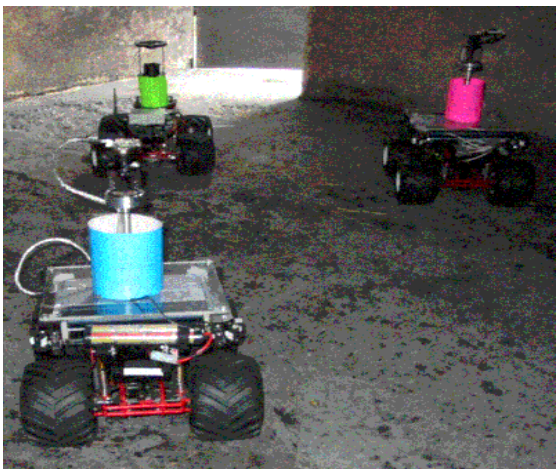
Recent Research Highlights

Tracking intruders on compromised computers. After a computer is broken into, it is imperative for the administrator to learn how the intruders broke into the system, what secrets they stole, what data they modified, and what further attacks they enabled or launched. Unfortunately, administrators currently rely on sketchy logs, guesswork, and luck when analyzing intrusions. Careful intruders can hide their tracks by disabling monitoring software, by encrypting their communication, or by performing non-deterministic actions that an administrator cannot reliably repeat.

An NSF-supported Principal Investigator and his students have developed a virtual-machine based system called ReVirt that can trace an intruder's every action. This tracing is performed at such a fine level of detail that an administrator can reenact every instruction an intruder executed to break into a computer, as well as every instruction the intruder performed after breaking into the computer. The tracing slows execution by only a few percent and can store a day of activity on $1 of disk storage. This research was presented at the Symposium on Operating Systems Design and Implementation.

The work represents a new approach to applying the concept of virtual machines that supports identifying and recovering from damage following penetration of a computer. The work is notably novel, effective, and practical.

Active sensor networks for emergency response. Researchers studying networked, sensor-carrying robots at the University of Pennsylvania recently engaged in on-site experiments at the Allegheny County (Pennsylvania) Fire Academy Test Facility. Robots were sent into a smoking building with various kinds of sensors onboard. Movies and photos of the experiments can be found on a University of Pennsylvania Web site for the Allegheny Fire Academy Tests.

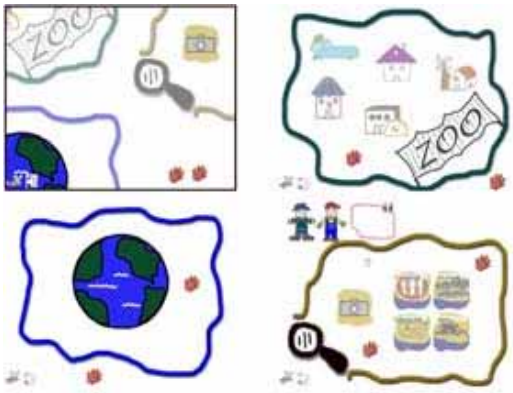


Researchers on this Information Technology Research project conduct both fundamental and applied embedded and hybrid systems research. In this project, results are deployed for experimentation using mobile robots. The project seeks to acquire and integrate various types of data from sensor networks (temperature, acoustics, range, visible and infrared imaging). These experiments are expected to provide a cost/benefit analysis of how these technologies and algorithms will be able to benefit fire fighters.

This project illustrates important concrete benefits for society of research in robotics, sensor nets, and embedded systems.

Digital Libraries for Children: Computation Tools that Support Children as Researchers.

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



- The development of a digital library prototype (SearchKids) where children can search for animals using a zoomable visual querying interface. Multiple children can use this tool at the same time thanks to a special interface that enables multiple

pointing devices (mice) to be used simultaneously on one computer. This tool is linked to a zoomable presentation tool (KidPad), which enables children to use their animal resources to tell stories.

- The evaluation of the software with 120 2nd and 3rd grade children: The team has worked extensively in early elementary school classrooms to understand children's search strategies and approaches to collaboration. These studies have shown that young children not normally capable of complex Boolean searches can do so more efficiently and accurately given a visual interface. In addition, collaboratively navigating information necessitates various interface technologies that encourage cooperation and peer learning.

- The beginning of generalization of the interface on two fronts. The team has begun generalizing the technology infrastructure to work with other databases. They have begun generalization efforts by working with the University of Michigan's Bio Diversity animal database. In addition, the team has initiated a new research project with the Library of Congress and the Internet Archive to develop the largest international children's book digital library in the world.

Federal Crosscuts

NSF will continue its active participation in federal crosscut areas in FY 2005, supporting research and education in the Networking and Information Technology Research and Development program at $760.0 million, the National Nanotechnology Initiative at $305.06 million, and $210.02 million for Climate Change, including $185.0 million for the U.S. Global Change Research Program and $25.0 million for the Administration's Climate Change Research Initiative (CCRI), first proposed in FY 2003. The CCRI is a multiagency effort with a strong focus toward short-term outcomes and deliverables. NSF will participate in four specific areas: understanding the North American carbon cycle, research on climate change risk management, developing sensors to measure carbon dioxide and methane, and measuring and understanding the impact of black carbon.

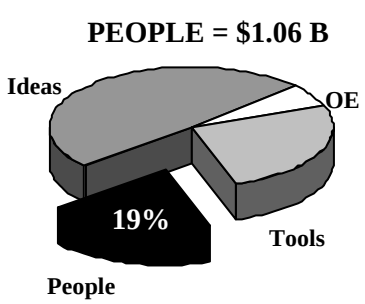
People

A diverse, competitive, and globally-engaged U.S. workforce of scientists, engineers, technologists and well-prepared citizens.

People Funding by Investment Category
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Individuals	471.53	477.39	498.85	21.46	4.5%
Institutions	182.54	180.15	172.35	-7.80	-4.3%
Collaborations	462.93	476.23	393.62	-82.61	-17.3%
Total, People	$1,117.00	$1,133.77	$1,064.82	-$68.95	-6.1%

Totals may not add due to rounding.



Leadership in today's knowledge economy requires world-class scientists and engineers and a national workforce that is scientifically, technically and mathematically strong. Investments in People aim to improve the quality and reach of science, engineering, and mathematics education and enhance student achievement. Each year, NSF supports more than 200,000 people – teachers, students, and researchers at every educational level and across all disciplines in science and engineering – and provides support for public science-literacy projects. Embedded in all NSF programs are efforts to build a more inclusive and globally engaged workforce that fully reflects the strength of the nation's diverse population.

Within the constraints of the overall FY 2005 Request for People, it is not possible to accommodate the priority increases while increasing or even maintaining all programs in the portfolio at the FY 2004 Estimate. Increases requested for the highest priorities, the Integrative Graduate Education and Research Traineeships (IGERT), Graduate Research Fellowships (GRF) and Graduate Teaching Fellows in K-12 Education (GK-12) necessitated cuts in other programs. This required difficult decisions on where reductions could be taken while minimizing the adverse impact on program outcomes.

People Investment Categories: The three investment categories that support the People strategic outcome are Individuals, Institutions and Collaborations. They tie directly to NSF programs and budget resources and provide the framework for the Program Assessment Rating Tool (PART) analysis of NSF performance.

FY 2005 Annual Performance Goal for People: NSF will demonstrate significant achievement for the majority of the following performance indicators related to the People outcome goal:

- Promote greater diversity in the science and engineering workforce through increased participation of underrepresented groups in NSF activities.

- Support programs that attract and prepare U.S. students to be highly qualified members of the global S&E workforce, including providing opportunities for international study, collaborations and partnerships.
- Promote public understanding and appreciation of science, technology, engineering, and mathematics, and build bridges between formal and informal science education.
- Support innovative research on learning, teaching and education that provides a scientific basis for improving science, technology, engineering and mathematics education at all levels.
- Develop the nation's capability to provide K-12 and higher education faculty with opportunities for continuous learning and career development in science, technology, engineering and mathematics.

Baseline / Prior Year Results: FY 2001 was the first year that NSF had an annual performance goal with associated annual performance indicators for People. Each fiscal year's performance indicators may differ from those of prior years, but in all cases they serve as measures of progress toward achievement of NSF's strategic outcome goal. NSF was successful in achieving the annual performance goal associated with the People strategic outcome in FY 2001, FY 2002 and FY 2003.

Means and Strategies for Success:

- Support, through merit-based grants and cooperative agreements, the most promising and capable individuals and groups throughout the U.S.
- Pay particular attention to development of people beginning careers in science and engineering.
- Use all aspects of NSF activity to embed diversity in the science and engineering workforce.
- Maintain existing partnerships and explore opportunities for developing new partnerships that focus on broadening participation. These include making presentations at national and regional meetings involving minority-serving organizations and at formal meetings of NSF programs (e.g., EPSCoR and LSAMP).
- Focus on (a) preparation and professional development of teachers of mathematics and science, and (b) alignment of standards, rigorous curricula and assessments.
- Support the production of well-trained researchers and educators by providing a variety of NSF activities (e.g., programs with industry; NSF centers) to afford interactive research and education opportunities for students, post-doctoral scientists and faculty at all career stages.

Student from the REU Program operated by the Association of American State Geologists and the California Geological Survey conducting field research in the San Gabriel Mountains. *Credit: Jonathan A. Nourse, California State Polytechnic University, Pomona.*

- Support approaches that integrate research and learning activities, encourage the partnering of the K-12 and higher education communities and develop intellectual capital.
- Encourage attendance at international meetings, faculty/student exchange opportunities, and research utilizing international facilities and field/logistics centers in order to further engage the NSF community in international activities.
- Promote increased linkages between formal programs and informal activities such as those involving museum and science center exhibits, public fora, or the Internet in order to communicate with the public.

INDIVIDUALS

Investments that ensure development of world-class scientists, engineers, mathematicians, technologists, and educators.

Individuals Funding by Program
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
CAREER	133.87	130.68	130.68	0.00	0.0%
Graduate Research Fellowships	85.02	97.27	103.30	6.03	6.2%
IGERT	57.85	67.00	81.74	14.74	22.0%
Postdocs	17.84	17.46	18.31	0.85	4.9%
REU Supplements	23.59	21.20	21.47	0.27	1.3%
Scholarships for Service	30.14	16.08	16.18	0.10	0.6%
Teacher Professional Continuum	66.65	62.16	62.16	0.00	0.0%
VIGRE	19.00	25.78	27.78	2.00	7.8%
Other	37.57	39.76	37.23	-2.53	-6.4%
Total, Individuals	$471.53	$477.39	$498.85	$21.46	4.5%

Request Level: $498.85 million (+$21.46 million)

NCAR Undergraduate Leadership Workshop visiting the NSF C-130 aircraft. *Credit: University Corporation for Atmospheric Research.*

- NSF is adding $14.74 million to Integrative Graduate Education and Research Traineeships (IGERT), for a total of $81.74 million and adding $6.03 million to Graduate Research Fellowships (GRF), for a total of $103.30 million. This supports approximately 450 additional graduate students. These awards are available to those graduate students who are U.S. citizens or nationals. The IGERT program is intended to catalyze a cultural change in graduate education, for students, faculty, and institutions, by establishing innovative new models for graduate education and training in a fertile environment for collaborative research that transcends traditional disciplinary boundaries. It is also intended to facilitate greater diversity in student participation and preparation. GRF offer recognition and three years of support for advanced study to outstanding graduate students.
- Support for one of NSF's most prestigious programs, Faculty Early Career Development (CAREER), remains at the FY 2004 Estimate of $130.68 million. The Foundation-wide CAREER program recognizes and supports the early career-development activities of those teacher-scholars who are most likely to become the academic leaders of the 21st century.
- Research Experiences for Undergraduates Supplements increase by $270,000 to a total of $21.47 million.

- The Teacher Professional Continuum program (TPC) is funded at $62.16 million, level with the FY 2004 Estimate, to support the development of master teachers with strong disciplinary and pedagogical content knowledge who will then serve as agents of change in their school districts. These projects will include an education research component to assess the impact on teacher learning and instructional skills, as well as strategies for effectively transferring professional development experiences back to classrooms. These leadership efforts will address particular needs of more advanced instructional materials, e.g., those associated with innovative science and mathematics.
- Support for Enhancing the Mathematical Sciences Workforce for the 21st Century (the broadening of Vertical Integration of Research and Education in the Mathematical Sciences (VIGRE)) increases by $2.0 million to $27.78 million. This will provide support for additional postdoctoral fellowships, graduate traineeships, research experiences for undergraduates, and innovative programs to increase the number of students who pursue advanced education and training in the sciences.

Highlights of Other Individuals support include:

- NSF will expand support for research experiences for graduate students through an extension of the East Asia graduate research summer institute model to other countries. Currently this program exists in Japan, Taiwan, Korea, China, and Australia. This program will be increased by $550,000. The Foundation will also initiate a new $250,000 fellowship program for senior researchers pursuing collaborative research with scientists and engineers in developing countries.
- Support for the Opportunities to Enhance Diversity in the Geosciences (OEDG) program will be increased by $600,000 to a total of $4.60 million. This program seeks to increase participation in geosciences education and research by students from groups historically underrepresented in the geosciences.
- Support for the post-doctoral program Discovery Corps, which will be piloted in FY 2004, will increase by $500,000 to a total of $1.50 million. This program will enhance the research skills of the participants and contribute to the development of national research infrastructure.

Scientists from Michigan State (MSU) and Stanford universities, sponsored through CAREER, in a fresh look at world population dynamics, have revealed evidence that increased numbers of households, even where populations are declining, are having a vast impact on the world's biodiversity and environment. *Credit: Sue Nichols, Michigan State University.*

FY 2005 Annual Performance Goal within Individuals: Stipend level of $30,000 for students supported through the IGERT and GRF programs.

IGERT and GRF Stipend Level

	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Goal	$15,000	$16,000	$18,000	$25,000	$30,000	$30,000
Result	$16,200	$16,800	$21,500	$27,500	N/A	N/A

N/A = Not Available

Program Assessment Rating Tool (PART) Evaluation: A PART on the Individuals investment category was completed to inform the FY 2005 budget decision-making process. Overall, the PART assessment found Individuals to be an “effective” program. With respect to program purpose and design, the PART review found that the program’s purpose, to "ensure development of world-class scientists, mathematicians, technologists and educators", is clear. The program addresses the need to prepare future

generations of scientists, mathematicians, and engineers who will be necessary to ensure America's leadership in the global marketplace. The Individuals investment category addresses unique national STEM workforce needs that are not under the purview of mission-oriented federal, state or local agencies. The program relies on the competitive merit review process, the NSF Program Officers in their oversight capacity, and independent, external Committees of Visitors (COVs) to ensure effectiveness and efficiency.

With respect to strategic planning, Individuals was found to have a limited number of long-term performance measures with ambitious targets and timeframes, which focus on outcomes and meaningfully reflect the purpose of the program. These measures are significant achievement, as assessed by external experts, in 1) promoting diversity in the science and engineering workforce through increased participation of underrepresented groups in NSF activities and 2) attracting and preparing U.S. students to be highly qualified members of the global S&E workforce.

NSF is in the process of developing appropriate measures, baselines, and targets for its investments in Individuals. Until now, NSF's assessment processes have been based on qualitative evaluations (under the "alternative format" authorized by the Government Performance and Results Act). The agency has identified a number of potential quantitative annual measures that relate directly to the agency's strategic goals. These provide valuable indicators of progress, but further analysis is required before specific baselines and targets can be identified.

Evaluations are conducted regularly in order to inform program improvements and influence program planning. Each activity at NSF is reviewed once every three years by a COV. NSF's approach to evaluation was recently highlighted by GAO as an "evaluation culture–a commitment to self-examination, data quality, analytic expertise, and collaborative partnerships." Performance information informs NSF's budget decisions and is incorporated into NSF's budget requests to the Congress. For NSF's investments in Individuals, for example, the FY 2004 Budget Request highlighted the accomplishments of recipients of NSF graduate fellowships, noting that four former GRF recipients received the Nobel Prize in 2001 and two received the National Medal of Science. The budget also clearly presents the resource request for each program and outlines the activities that will be supported with the funds.

With respect to program management, Individuals was found to collect timely and credible performance information and to use it to manage the program and improve performance. Individuals was also found to effectively coordinate and collaborate with related programs, use strong financial management processes and obligate funds in a timely manner.

The investment category has demonstrated adequate progress in achieving its long-term goals, as qualitatively evaluated by external experts. Its performance compares favorably to other programs with similar purpose and goals. The complete PART can be found online at http://www.whitehouse.gov/omb/budget.

Means and Strategies for Success – Individuals:

- Promote greater diversity in the science and engineering workforce through increased participation of underrepresented groups and institutions in NSF activities. NSF promotes diversity by embedding it throughout its investment portfolio.
- Support programs that attract and prepare U.S. students to be highly qualified members of the global S&E workforce, including providing opportunities for international study, collaborations and partnerships.
- Develop the nation's capability to provide K-12 and higher education faculty with opportunities for continuous learning and career development in science, technology, engineering and mathematics.

INSTITUTIONS

Investments that enable colleges, universities and other institutions to attract increased numbers of students to S&E fields and enhance the quality of S&E education at all levels.

Institutions Funding by Program
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
ADVANCE	17.18	19.16	20.27	1.11	5.8%
Advanced Technological Education	42.33	45.23	38.16	-7.07	-15.6%
Course, Curriculum and Laboratory Improvement	54.20	44.99	50.97	5.98	13.3%
Instructional Materials and Assessment Development	27.36	28.82	29.45	0.63	2.2%
STEM Talent Expansion Program	21.29	24.85	15.00	-9.85	-39.6%
Other	20.18	17.10	18.50	1.40	8.2%
Total, Institutions	$182.54	$180.15	$172.35	-$7.80	-4.3%

Request Level: $172.35 million (-$7.80 million)

- ADVANCE totals $20.27 million, an increase of $1.11 million over the FY 2004 Estimate. The goal of ADVANCE is to increase the participation of women in the scientific and engineering workforce through the increased representation and advancement of women in academic science and engineering careers.
- Advanced Technological Education (ATE), funded at $38.16 million, a decrease of $7.07 million from the FY 2004 Estimate, supports improvement in technician education in science- and engineering-related fields that drive the nation's economy, particularly at two-year colleges and secondary schools, by supporting the design and implementation of new curricula, courses, laboratories, educational materials, opportunities for faculty and student development, and collaboration among educational institutions and partners from business, industry, and government.
- EHR increases its Course, Curriculum and Laboratory Improvement (CCLI) program by $6.12 million to $46.53 million, bringing the total number of awards to approximately 305 with a funding rate of about 21 percent. Emphasis will be on assessment and evaluation, modern instrumentation, and curriculum and program development in emerging areas. Other course, curriculum, and laboratory improvement related efforts total $4.44 million across NSF for a total of $50.97 million.
- The Instructional Materials and Assessment Development (IMD) program will increase by $630,000 to a total of $29.45 million with emphasis on applied research focused on the design and impact of new approaches to disciplinary content and its implications for student learning, the instructional workforce, and education policy.
- The STEM Talent Expansion Program (STEP) is funded in FY 2005 at $15.0 million, a decrease of $9.85 million from the FY 2004 Estimate, which allows support for approximately ten awards. STEP seeks to increase the number of students (U.S. citizens or permanent residents) receiving associate or baccalaureate degrees in established or emerging fields within science, technology, engineering, and mathematics. The STEP decrease is due to the constraints of the overall People portfolio, in which it was not possible to maintain funding at the FY 2004 Estimate for all programs.

Highlights of Other Institutions support include:

- An additional $4.0 million will support Computer and Information Science and Engineering (CISE) demonstration projects that effectively link research and education and use best practices to attract more women and minorities; these projects will support recruiting and retaining students in computing science and engineering tracks along with improved outcomes for all students. These

efforts will build on prior CISE awards that provide a research base to understand the reasons for low participation in computer science and engineering education and career paths.

- Support for the Engineering Education Reform program at $13.47 million, a decrease of $2.02 million from the FY 2004 Estimate. This level of support, while decreasing emphasis on unsolicited proposals, continues to enable engineering departments to develop innovative curricula, incorporating interdisciplinary knowledge and allowing engineering schools to develop active partnerships with schools of education, for their mutual benefit.

NSF will consider annual performance goals related to the Institutions investment category appropriate for inclusion in a future performance budget at the time the PART for this program is completed.

Means and Strategies for Success – Institutions:

- Promote greater diversity in the science and engineering workforce through increased participation of underrepresented groups and institutions in NSF activities. NSF promotes diversity by embedding it throughout its investment portfolio.
- Support programs that attract and prepare U.S. students to be highly qualified members of the global S&E workforce, including providing opportunities for international study, collaborations and partnerships.
- Develop the nation's capability to provide K-12 and higher education faculty with opportunities for continuous learning and career development in science, technology, engineering and mathematics.
- Promote public understanding and appreciation of science, technology, engineering, and mathematics, and build bridges between formal and informal science education.
- Support innovative research on learning, teaching and mentoring that provides a scientific basis for improving science, technology, engineering and mathematics education at all levels.

COLLABORATIONS

Investments that foster partnerships with colleges, universities, school districts, and other institutions – public, private, state, local, and federal – to strengthen S&E education at all levels and broaden participation in S&E fields.

Collaborations Funding by Program
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Centers for Learning and Teaching	26.58	28.84	28.84	0.00	0.0%
Evaluation	12.50	11.57	11.57	0.00	0.0%
GK-12	42.40	49.85	55.70	5.85	11.7%
HBCU-UP	18.71	23.86	19.98	-3.88	-16.3%
Informal Science Education	60.23	62.13	50.00	-12.13	-19.5%
LSAMP	31.81	34.30	34.30	0.00	0.0%
Math and Science Partnership	144.07	139.17	80.00	-59.17	-42.5%
Partnerships for Innovation	4.97	9.94	10.00	0.06	0.6%
REU Sites	30.49	31.58	31.58	0.00	0.0%
Other	91.17	84.99	71.65	-13.34	-15.7%
Total, Collaborations	$462.93	$476.23	$393.62	-$82.61	-17.3%

Request Level: $393.62 million (-$82.61 million)

- Centers for Learning and Teaching (CLTs) are funded at $28.84 million, level with the FY 2004 Estimate. CLTs address the need to enrich and diversify the national infrastructure for standards-based science, technology, engineering, and mathematics education. The goal is to increase the number of K-12 educators prepared in content, pedagogy, and assessment methodologies.
- The Evaluation program, funded level with the FY 2004 Estimate at $11.57 million, will support development of methodological state-of-the-art approaches and the training of evaluators, especially at the graduate level, to meet the needs of the STEM education community.
- The GK-12 program will increase by $5.85 million to $55.70 million, providing support for approximately 50 additional graduate students. Students receiving this support must be U.S. citizens or nationals. Stipend levels will be maintained at $30,000.
- Support for the LSAMP program will be sustained at the FY 2004 Estimate of $34.30 million and the Alliances for Graduate Education and the Professoriate (AGEP) program will be funded at $14.91 million, level with FY 2004, to allow for continuing alliances and integration between the programs.
- In FY 2005, NSF begins the process of phasing out the MSP program. Funding of $80 million will continue support for (a) out-year commitments to *Comprehensive* and *Targeted* awards made in the first and second competitions and (b) data collection and program evaluation. The MSP is being consolidated in the Department of Education to concentrate attention and resources in a single program.
- Partnerships for Innovation (PFI) are funded at $10.0 million, slightly above the FY 2004 Estimate of $9.94 million. PFI promotes innovation by bringing together colleges and universities, State and local governments, private sector firms, and nonprofit organizations. These organizations form partnerships that support innovation in their communities by developing the people, tools, and infrastructure needed to connect new scientific discoveries to practical uses.
- Funding for Research Experiences for Undergraduates Sites will remain at the FY 2004 Estimate of $31.58 million.
- The overall FY 2005 decrease reflects completion of the planned phase-out of the Urban Systemic and Rural Systemic programs and decreases in support for the Math and Science Partnership (MSP) and the Informal Science Education program.

Highlights of Other Collaborations support include:

- Support of $3.0 million for the MPS pilot program proposed to begin in FY 2004 for Undergraduate Research Centers that support faculty teams working with teams of first- and second-year college students to attract a larger and more diverse group of students into the technical workforce will be continued. Support for MPS Internships in Public Science Education (IPSE) program will increase $500,000 to total $3.0 million.
- Investment in research and training activities at the scientifically rich interface between the MPS disciplines and the biological sciences will be increased by $400,000 to total $1.0 million.
- GEO sustains support for the Centers for Ocean Science Education at $2.60 million. This program is putting in place a distributed

A University of Rhode Island GK-12 Fellow (Catalina Martinez) and a student hold a flounder during a field experiment. The GK-12 Fellows received extensive training and were paired with teachers in grades 4-8. Both the Fellows and teachers attended a summer institute focused on marine science content and on pedagogy. *Credit: University of Rhode Island.*

set of center-like groups to develop and implement innovative education activities utilizing the world's oceans as an integrating theme.

NSF will consider annual performance goals related to the Collaborations investment category appropriate for inclusion in a future performance budget at the time the PART for this program is completed.

Means and Strategies for Success – Collaborations:

- Promote greater diversity in the science and engineering workforce through increased participation of underrepresented groups and institutions in NSF activities. NSF promotes diversity by embedding it throughout its investment portfolio.
- Support programs that attract and prepare U.S. students to be highly qualified members of the global S&E workforce, including providing opportunities for international study, collaborations and partnerships.
- Develop the nation's capability to provide K-12 and higher education faculty with opportunities for continuous learning and career development in science, technology, engineering and mathematics.
- Promote public understanding and appreciation of science, technology, engineering, and mathematics, and build bridges between formal and informal science education.
- Support innovative research on learning, teaching and mentoring that provides a scientific basis for improving science, technology, engineering and mathematics education at all levels.

HIGHLIGHTS OF RECENT ACCOMPLISHMENTS – PEOPLE

Examples of accomplishments of NSF-supported education and training programs are described below.

Lake Ecosystem Critical to East African Food Supply Is Threatened by Climate Change. In an important new study directly linking climatic warming with the survival of lake organisms, researchers have found multiple lines of evidence showing that increasing air and water temperatures and related factors are shrinking fish and algae populations in Lake Tanganyika in Africa. The lake holds 18 percent of the world's liquid freshwater and is a critical food source in East Africa. Researchers have reported that climate change in the region is harming the lake's ecosystem, decreasing fish stocks by as much as 30 percent over the past 80 years. NSF supports this research through the Nyanza Project, an interdisciplinary research-training program for undergraduate and graduate students and secondary school teachers based at the University of Arizona in Tucson. This project, part of the NSF Research Experiences for Undergraduates (REU) Program, links U.S. researchers with African researchers supported by the United Nations Global Environmental Fund's Lake Tanganyika Biodiversity Project.

Deploying the Hedrick Marrs multicorer. *Credit: Andrew Cohen, University of Arizona at Tucson; NSF.*

NCAR Undergraduate Leadership Workshop. In June 2002, the National Center for Atmospheric Research (NCAR) hosted the first annual NCAR Undergraduate Leadership Workshop to inform students about the potential for exciting research and career opportunities in the atmospheric and related sciences. The five-day workshop established informal dialogues between students and research scientists as they explored laboratories, instrumentation, and computing facilities that support studies on weather, climate change, solar dynamics, the Sun-Earth system, and the impacts of severe weather and climate change on societies around the world. Students gained insight into the

breadth of research topics in the atmospheric and related sciences, while they also learned about NCAR's collaborative role in university research. They were informed about opportunities for graduate and post-doctoral studies in the University Corporation for Atmospheric Research (UCAR) community of member and affiliate universities and colleges.

Center Aims to Bring More Women and Minorities into Engineering. To increase the number of women and minorities in the field of engineering, the Center for Wireless Integrated MicroSystems (WIMS), an Engineering Research Center (ERC) at the University of Michigan, has expanded its work into secondary schools. The Center sponsors four summer programs that use microsystems to excite students about using engineering to tackle important societal problems. The courses are designed to improve precollege students' skills in science, math, computer science, and communications. More than half of those enrolled were females, and one program targeted students from underrepresented groups (mainly African-Americans from urban schools). Some examples are:

- "*Legos to WIMS*" – a 5-day commuter program open to fifth through seventh grade students;
- The "*Detroit Area Pre-College Engineering Program (DAPCEP)/ WIMS Short Course*" – a 3-week residential program for students entering 11th and 12th grades, which is offered through the Diversity Programs Office at WIMS partner institution Michigan State University;
- "*WIMS for Women*" – a 6-day/5-night residential summer program; and
- "*WIMS for Teens*" – a 7-day/6-night residential summer program. The curriculum focuses on math integrated with science, Lego Mindstorm challenge activities, communication skills, and pre-engineering motivational activities.

Detroit: Improving Science and Math Education. The Detroit Urban Systemic Program (USP) assists the city's school district in implementing K-12 science and mathematics standards based on the Michigan Core Curriculum. Rigorous standards, cognitive engagement, personal relevance, pervasive technology, and capacity building are the five basic concepts that guide the constructivist approach to teaching and learning of the Core Curriculum in all 268 schools reaching the entire population of over 167,000 students. To increase the pool of qualified science and math teachers in the school district, the Detroit USP collaborated with Wayne State University to create an Alternative Pathway to Teaching program for teachers now under temporary certification who wish to work toward full certification. Likewise, the program collaborated with the University of Michigan to create a K-12 Masters of Arts with Certification that focuses on the preparation of science and math teachers in urban areas.

A Detroit math teacher provides guidance on the use of hand-held technology and real-world data to chart changes in the coordinates of a student as he changes position. *Credit: Detroit Public Schools.*

MLIAM: NESPOLE! - Negotiating Through Spoken Language in E-commerce. This research in the area of multi-lingual speech translation and communication has produced a prototype system that enables native users to connect with a "commercial" service provider that speaks a different language and receive detailed information via a live video-conferencing channel, in which speech-to-speech translation is seamlessly embedded. A simple and easy to use "whiteboard" application that allows the two parties to simultaneously view shared WebPages, maps, images, and annotated gestures complements the speech communication channel, significantly enhancing the effectiveness of communication. The speech-to-speech translation is accomplished via a unique

server architecture distributed over the Internet. Very minimal software is required on the end users' standard personal computers (PCs). This technology opens the door to new global e-commerce applications that transcend language barriers. The project uses an "*interlingua*" to support multiple language pairs, and has managed to achieve successful speech recognition of relatively low quality speech taken from video conferencing equipment. The NESPOLE! Project is funded under the MLIAM program with one U.S. partner (Carnegie Mellon University) and three European research partners: University of Karlsruhe (Germany), Joseph Fourier University (France), and ITC-irst (Italy). Two European industrial partners are also involved: AETHRA (an Italian telecommunications company), and APT (the Trentino provincial government tourism bureau). The partners work together on overall system architecture, interlingua design, evaluation, user studies, and Human Language Technology (HLT) component design.

International Children's Digital Library. Researchers at the University of Maryland's Human-Computer Interaction Lab and at the Internet Archive, a public, non-profit organization, are engaged in a 5-year project to create a digital library of international children's books. The primary goal of the project is to create a collection of 10,000 books in at least 100 languages that is freely available via the Internet to children, teachers, librarians, parents, and scholars throughout the world. The project leaders are collaborating with children as design partners in the development of computer interface technologies that support children in searching, browsing, reading, and sharing books in electronic form. The primary audience is children ages 3-13. The researchers worked with children in grades two and three to understand children's search strategies and approaches to collaboration. Their studies showed that young children not normally capable of complex Boolean searches could do so more efficiently and accurately given a visual interface. The International Children's Digital Library aims to make "the largest bookmobile in history" available to children around the world.

Credit: International Children's Digital Library.

Number of People Involved in NSF Activities

Over 200,000 people are directly involved in NSF programs and activities, receiving salaries, stipends, or participant support. In addition, NSF programs indirectly impact many millions of people. These programs reach preK-12 students and preK-12 teachers, the general public and researchers through activities including workshops; informal science activities such as museums, television, videos, and journals; outreach efforts; and dissemination of improved curriculum and teaching methods. The FY 2005 decrease in the number of people involved in NSF activities reflects the phasing out of the Math and Science Partnership program and other reductions in the EHR budget, which will result in fewer K-12 students and teachers supported, and the overall decrease in the estimated number of awards, which will result in fewer senior researchers, other professionals, postdoctoral associates, and undergraduate students supported by NSF.

Number of People Involved in NSF Activities

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Senior Researchers	31,040	31,400	30,970
Other Professionals	14,340	14,500	12,680
Postdoctoral Associates	6,120	6,240	6,080
Graduate Students	27,620	28,640	28,870
Undergraduate Students	34,890	35,260	33,210
K-12 Students	13,310	14,320	10,820
K-12 Teachers	84,980	86,220	82,780
Total Number of People [1]	212,300	216,580	205,410

[1] Does not include individuals funded through H-1B Nonimmigrant Petitioner Receipts.

Senior Researchers include scientists, mathematicians, engineers, and educators receiving funding through NSF awards. These include both researchers who are principal or co-principal investigators on research and education projects, and researchers working at NSF-supported centers and facilities.

Other Professionals are individuals who may or may not hold doctoral degrees or its equivalent, who are considered professionals, but are not reported as senior researchers, postdoctoral associates, or students. Examples are technicians, systems experts, etc.

Postdoctoral Associates are individuals who have received Ph.D., M.D., D.Sc., or equivalent degrees and who are not members of the faculty of the performing institution. Most are supported through funds included in research projects, centers or facilities awards. The balances are recipients of postdoctoral fellowships.

Graduate Students include students compensated from NSF grant funds. Some of these students receive support through programs such as the NSF Graduate Research Fellowships, Integrative Graduate Education and Research Traineeship Program (IGERT), and NSF Graduate Teaching Fellowships in K-12 Education. The balance assists senior researchers or postdoctoral associates in performing research, and are supported through funds included in research projects, centers, or facilities awards. NSF provides support for approximately five percent of the science and engineering graduate students in the U.S.

Undergraduate Students include students enrolled in technical colleges or baccalaureate programs compensated from NSF grant funds. They may either be assisting senior researchers or postdoctoral associates in performing research, or participating in NSF programs specifically aimed at undergraduate students, such as Research Experiences for Undergraduates and the Louis Stokes Alliances for Minority Participation.

K-12 Students are those attending elementary, middle, and secondary schools. They are supported through program components that directly engage students in science and mathematics experiences such as teacher and student development projects.

K-12 Teachers include teachers at elementary, middle, and secondary schools. These individuals actively participate in intensive professional development experiences in sciences and mathematics.

Ideas

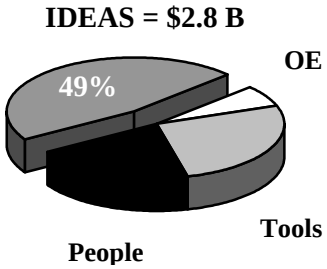
Discovery across the frontier of science and engineering, connected to learning, innovation, and service to society.

Investments in *Ideas* are aimed at the frontier of science, mathematics, and engineering. They build the intellectual capital and fundamental knowledge that drive technological innovation, spur economic growth, and increase national security and welfare. These investments also seek answers to the most fundamental questions about the origin and nature of the universe and life.

NSF's FY 2005 Request for Ideas totals $2,845.05 million, a $56.06 million increase from the FY 2004 Estimate of $2,788.99 million. 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 priority areas is 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, engineering, and education technology.

Ideas Funding by Investment Category
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Fundamental Science and Engineering	2,095.56	2,124.25	2,150.44	26.19	1.2%
Capability Enhancement	229.21	251.72	237.35	-14.37	-5.7%
Centers Programs	364.23	413.02	457.26	44.24	10.7%
Total, *Ideas*	$2,689.00	$2,788.99	$2,845.05	$56.06	2.0%



Ideas Long-Term Investment Categories: The three long-term investment categories that support the Ideas strategic outcome goal are Fundamental Science and Engineering, Capability Enhancement, and Centers Programs. They tie directly to NSF programs and budget resources, and provide the framework for analysis of NSF performance using the Program Assessment Rating Tool (PART).

FY 2005 Annual Performance Goal for *Ideas*: NSF will demonstrate significant achievement for the majority of the following performance indicators related to the *Ideas* outcome goal:

- Enable people who work at the forefront of discovery to make important and significant contributions to science and engineering knowledge;
- Encourage collaborative research and education efforts – across organizations, disciplines, sectors and international boundaries;
- Foster connections between discoveries and their use in the service of society;
- Increase opportunities for individuals from underrepre-sented groups and institutions to conduct high quality, competitive research and education activities;

- Provide leadership in identifying and developing new research and education opportunities within and across science and engineering fields; and
- Accelerate progress in selected science and engineering areas of high priority by creating new integrative and cross-disciplinary knowledge and tools, and by providing people with new skills and perspectives.

NSF funded a study on the corona of the Sun, shown here in white light. Undergraduate students formed an integral component of the eclipse expedition and developed both interest and expertise in astronomy.

Means and Strategies for Success:

NSF utilizes the following means and strategies to achieve the strategic outcome goal of Ideas and its associated long-term investment categories and annual performance goals:

- Support the most promising ideas through merit-based grants and cooperative agreements to individual researchers and groups, in partnership with colleges, universities, and other institutions – public, private, state, local, and federal – throughout the U.S.;
- Encourage partnerships and cooperative research efforts – among disciplines, in different sectors, and across international boundaries;
- Take informed risks in emerging research areas where consensus on appropriate directions (e.g., theory, methodology, or knowledge) is just beginning to form;
- Partner with a diverse range of investigators (e.g., new, minority) and institutions (e.g., research universities, community colleges, EPSCoR states, minority-serving institutions);
- Identify and support major cross-disciplinary priority areas where U.S. and NSF leadership are important;
- Identify and provide support for new and emerging opportunities;
- Develop and support a high-quality, balanced award portfolio that considers disciplines and fields, interdisciplinary research areas, and emerging opportunities;
- Utilize the NSF core strategies of integrating research and education, promoting partnerships, and developing intellectual capital; and
- Provide grants of sufficient size and duration to improve the efficiency of the research process.

Baseline / Prior Year Results: FY 2001 was the first year that NSF defined an annual performance goal with associated annual performance indicators for Ideas. Each fiscal year's performance indicators differ slightly from those of prior years, but in all cases they serve as measures of progress toward achievement of NSF's strategic outcome goal. NSF was successful in achieving the annual performance goal associated with the Ideas strategic outcome in FY 2001, FY 2002, and FY 2003.

FY 2005 Annual Performance Goal – Award Size: NSF will increase the average annualized award size for research grants to $142,000.

Average annualized award size for research grants.								
	FY 1998	**FY 1999**	**FY 2000**	**FY 2001**	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**
Baseline	$90,000							
Goal				$110,000	$113,000	$135,000	$139,000	$142,000
Result		$94,000	$105,800	$113,601	$115,666	$136,000	&	&

& = Data not yet available

FY 2005 Annual Performance Goal – Award Duration: The average duration of awards for research grants will be 3.0 years.

Average duration of awards for research grants (in years).								
	FY 1998	**FY 1999**	**FY 2000**	**FY 2001**	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**
Baseline	2.7							
Goal		2.8	N/A	3.0	3.0	3.0	3.0	3.0
Result		2.8	2.8	2.9	2.9	2.9	&	&

& = Data not yet available

Means and Strategies for Success (Award Size and Duration):

- Use electronic monitoring systems to track average award size and duration and to modify funding strategies as needed.
- Increase award size for priority areas, focused competitions, and other programs.

Resources Required: Approximately $40.0 million is needed to increase average annualized award size from the FY 2004 goal of $139,000 to $142,000 in FY 2005, assuming that there is a slight decrease from the FY 2004 number of awards and that the FY 2005 average award duration continues at approximately 3.0 years as in FY 2004.

FUNDAMENTAL SCIENCE AND ENGINEERING

This investment category provides funds to support the best new ideas generated by scientists and engineers working at the forefront of discovery. These funds support single investigators and small groups, and provide the primary support for early career faculty and students. They are extremely important in invigorating the research community since they promote emergence of new ideas and fields, especially in areas where disciplines are blurred and new technologies merge. Investments in these activities ensure the vitality of a broad array of scientific and engineering fields needed to maintain U.S. leadership in science and engineering.

NSF relies on a competitive, merit-based process to identify the most promising research directions in established fields, and increasingly, to open new frontiers across a broad front of disciplines through multidisciplinary investigations. The continuing vitality of core disciplines is the lifeblood of the research and education enterprise.

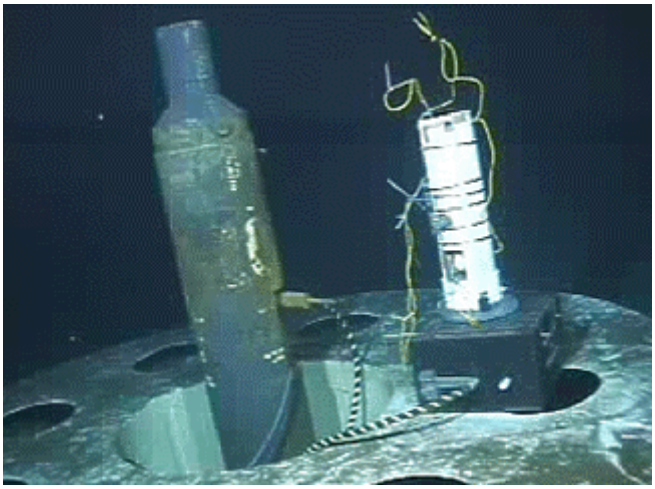
It is particularly important in today's research climate, where advances in one field can rapidly lead to new insights in others. The accelerating pace of discovery, combined with new information and communication tools, has produced unprecedented opportunities for these synergies. Information research and technology, for example, have enabled rapid progress in virtually every discipline from molecular biology to astronomy, and from particle physics to the social and behavioral sciences.

Fundamental Science and Engineering Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Disciplinary Research	2,058.33	2,082.20	2,103.39	21.19	1.0%
Arctic Research Commission	1.08	1.19	1.19	0.00	0.0%
Innovation Fund	N/A	N/A	5.00	5.00	n/a
Interagency Education Research Initiative (IERI)	24.85	24.54	24.54	0.00	0.0%
Plant Genome Research	11.30	16.32	16.32	0.00	0.0%
Total, Fundamental Science and Engineering	$2,095.56	$2,124.25	$2,150.44	$26.19	1.2%

Highlights include:

- The NSF average annualized research grant award size will increase to approximately $142,000 and research award duration will continue at approximately 3.0 years.
- NSF's investments in cyberinfrastructure research represent the integration of state-of-the-art computing, communications and information technologies, tools and services in an infrastructure framework designed to radically empower the Nation's science and engineering research and education community.
- The new Innovation Fund, initiated at $5.0 million, will enable investment in strategic, community-driven, frontier activities.
- The 'core' of biological sciences research will increase, bringing the average award size to $190,750 per year. Focus areas include Frontiers in Biological Research, environmental genomics, molecular level understanding of life processes, and cyber-tools and services that will enable biological research and education.



With awards from the Ocean Technology and Interdisciplinary Program and the Biological Oceanography Program, researchers at the University of Hawaii have succeeded in developing methods to sample deep within the environment of oceanic crust. The research indicates that crustal fluids support a diversity of microbial life. Pictured here is the BioColumn sampling device used to sample crustal fluids.

- Computer and information science and engineering will increase award size to $165,000 and duration to 3.1 years with an emphasis on new IT technologies for cyberinfrastructure and science of design, along with strengthening 'cybertrust' – moving networking and computing to a state in which people justifiably rely on computer-based systems' performance. Other priorities include programs in Understanding, Inference and Data, Data Driven Science, Formal and Mathematical Foundations Program, Foundations of Computing Processes and Artifacts, Emerging Models and Technologies for Computation, Next Generation Systems, and Next Generation Networks.
- Engineering investments will be focused on emerging technologies – nanotechnology, cyberinfrastructure and biotechnology. Added support will be distributed among: Sensor and Sensor Networks, to increase proposal funding rates; a cross-directorate linkage of molecular structure with all levels of function in biological and non-biological membrane systems; and the current portfolio of

energy investments focused in the areas of novel energy sources, resource recovery, energy infrastructure and energy conversion and utilization.

- Research in the geosciences will support initial science projects utilizing EarthScope, fund a new Biogeoscience program enabling additional projects to examine processes at the interface between the living and non-living environment, and provide added support of targeted interdisciplinary research into carbon and water cycles.
- Fundamental Science and Engineering levels in the mathematical and physical sciences will initiate support for understanding the newly emerging area of physics of the universe, linking the very smallest and very largest of spatial and temporal scales; enhance the understanding of the physical and chemical bases of life processes, with an emphasis on the molecular level; increase the NSF priority area in Nanoscale Science and Engineering with an emphasis on structures, phenomena, and quantum control at the nanoscale; enhance support for cyberinfrastructure through new algorithms that enable the exploration of previously inaccessible science; as well as continue efforts in NSF's Mathematical Sciences priority area.
- Special emphases in social, behavioral and economic sciences will include research on cognition, the disparate involvement of members of different groups on the nation's science and technology workforce, human interaction with the natural environment over space and time, and an expansion of research on organizations.
- Polar research will expand frontiers in polar genomics, cyberinfrastructure, environmental observatories, and sensors.
- Expanded international activities will include new partnerships involving U.S. and international collaborators working at promising fundamental research frontiers. Efforts in global networking to facilitate communication and collaboration between the U.S. and the international science and engineering community will also be supported.

NSF will consider annual performance goals related to the Fundamental Science and Engineering subgoal appropriate for inclusion in a future performance budget at the time the PART assessment for this program is completed.

CAPABILITY ENHANCEMENT

These investments enhance the capability of individuals and institutions to conduct high quality, competitive research, education, and technological innovation. For example, the Small Business Innovation Research (SBIR) program, pioneered by NSF, stimulates technological innovation in the private sector by strengthening the role of small business concerns in conducting high quality science and engineering research. The Experimental Program to Stimulate Competitive Research (EPSCoR) promotes the development of state-level science and technology resources through partnerships involving a state's universities, industry, and government.

Capability Enhancement Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
CREST	8.66	14.91	10.88	-4.03	-27.0%
EPSCoR	89.21	94.44	84.00	-10.44	-11.1%
ROA	0.83	1.29	1.29	0.00	0.0%
RUI	33.43	31.19	31.09	-0.10	-0.3%
SBIR/STTR	90.92	103.59	104.09	0.50	0.5%
Industry/Univ Coop Research, and State/IUCRC	6.16	6.30	6.00	-0.30	-4.8%
Total, Capability Enhancement	$229.21	$251.72	$237.35	-$14.37	-5.7%

Request Level: $237.35 million (-$14.37 million)

- The Small Business Innovative Research (SBIR) program increases by $450,000 to a total of $93.16 million, consistent with statutory requirements.
- The Small Business Technology Transfer (STTR) program, providing funding at the mandated level, will increase by $50,000 to $10.93 million.
- EPSCoR decreases by $10.44 million to a total of $84.0 million in FY 2005. EPSCoR will be supplemented in FY 2005 by approximately $30.0 million in co-funding from the Research and Related Activities Account, bringing total EPSCoR support to approximately $114.0 million.
- Research at Undergraduate Institutions (RUI) decreases by $100,000 to a total of $31.09 million.

NSF will consider annual performance goals related to the Capability Enhancement investment category appropriate for inclusion in a future performance budget at the time the PART assessment for this program is completed.

CENTERS PROGRAMS

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 coordination and team-based cross-disciplinary research.

Centers Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Centers for Analysis and Synthesis	2.86	6.15	6.47	0.32	5.2%
Chemistry Centers	13.39	16.85	18.90	2.05	12.2%
Earthquake Engineering Research Centers	6.00	6.00	6.00	0.00	0.0%
Engineering Research Centers and Groups	65.72	65.55	63.49	-2.06	-3.1%
Information Technology Centers	76.46	74.00	75.00	1.00	1.4%
Long-Term Ecological Research Program	18.06	20.52	22.82	2.30	11.2%
Materials Centers	54.65	56.56	58.90	2.34	4.1%
Mathematical Sciences Research Institutes	14.77	15.10	16.60	1.50	9.9%
Nanoscale Science and Engineering Centers	12.08	30.69	33.79	3.10	10.1%
Physics Frontiers Centers	12.25	15.20	15.40	0.20	1.3%
Plant Genome Virtual Centers	36.00	36.00	36.00	0.00	0.0%
Science and Technology Centers	44.07	42.52	72.39	29.87	70.2%
Science of Learning Centers	2.19	19.88	20.00	0.12	0.6%
SBE Centers	5.73	8.00	11.50	3.50	43.8%
Total, Centers	$364.23	$413.02	$457.26	$44.24	10.7%

Request Level: $457.26 million (+$44.24 million)

- In FY 2005, a new competition for the next class of Science and Technology Centers will be supported with $30.0 million.
- Funding for on-going awards and approximately 20 new catalyst awards for Science of Learning Centers (SLCs) totals $20.0 million.
- The Long Term Ecological Research (LTER) investment increases by $2.30 million, to a total across NSF of $22.82 million. Increased funding responds to computational advances and the increasing complexity of research questions being addressed at each LTER site.
- Centers receiving funding from the mathematical and physical sciences are enhanced by an additional $6.09 million to a total of $109.80 million, spread across Chemistry Centers (+$2.05 million), Materials Centers (+$2.34 million), Mathematical Sciences Research Institutes (+$1.50 million), and Physics Frontiers Centers (+$200,000).
- Nanoscale Science and Engineering Centers (NSECs) receive an additional $3.10 million, to a total of $33.79 million. These additional funds will support two new nanotechnology centers with needed new multidisciplinary capabilities, and will enhance award size of some existing centers.

NSF will consider annual performance goals related to the Centers Programs subgoal appropriate for inclusion in a future performance budget at the time the PART for this program is completed.

Description of NSF Centers

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 issues. NSF's FY 2005 support for the CEAS program is $3.47 million.

Center for the Synthesis of Biological Evolution

Initial funding of approximately $3.0 million in FY 2004 will support the Center for the Synthesis of Biological Evolution. The Center will provide mechanisms to foster synthetic, collaborative, cross-disciplinary studies in evolutionary biology. It will play a pivotal role in the further unification of the biological sciences as it draws together knowledge from disparate biological fields to increase our general understanding of biological design and function. Finally, the Center will play a critical role in organizing and synthesizing evolutionary knowledge that will be useful to policy makers, government agencies, educators and society. FY 2005 funding will be maintained at the FY 2004 Estimate of $3.0 million.

Chemistry Centers

Chemistry Centers include the Environmental Molecular Science Institutes (EMSIs), Collaborative Research in Chemistry (CRC), and the Laboratory for Molecular Sciences (LMS). In addition, new centers, Chemical Bonding Centers (CBCs), were proposed in FY 2004 to attack grand challenges in our understanding of the nature of the chemical bond. CBCs will investigate such problems as the molecular basis of life processes, the molecular origins of life, the rational design of catalytic systems, and the control of chemical reactions by lasers. In FY 2005, NSF will provide $18.90 million, an increase of $2.05 million (12.2 percent) over the FY 2004 Estimate of $16.85 million, to support 11 new centers, bringing the total to 40 centers.

Children's Research Initiative Centers

The Children's Research Initiative (CRI) supports a variety of research activities, including small research centers, individual investigator awards, collaborative proposals, and workshops. Together, the research centers represent a new thrust in the field of integrative developmental science; individually, they support leading-edge research about children and media, developmental science, and the integration and dissemination of developmental science to inform both research and policy. Centers established from FY 2001 through FY 2003 are located at the University of North Carolina-Chapel Hill, Cornell University, New York University, and the University of Michigan. A fifth center is a collaboration among four universities: Georgetown University, Northwestern University, University of Texas-Austin, and University of California-Los Angeles. No additional centers will be established in FY 2004 or FY 2005. Annual commitments to these centers total $2.50 million.

Climate Change Research Initiative Centers

Support will continue in FY 2005 for three to five centers focusing on Decision Making Under Uncertainty related to climate variability and change as part of the government-wide Climate Change Research Initiative. The centers will involve interdisciplinary teams that will advance understanding of all facets of decision-making processes related to climate change and other problems for which

information exists but uncertainty remains. Centers also will increase knowledge of the content and form of information needed by decision makers, develop tools to support decision makers and increase their ability to make sound decisions over multiple time scales, and facilitate interaction among researchers and decision makers, thereby enhancing fundamental research and increasing the speed with which new research findings are adopted and used by decision makers. The FY 2005 investment in these centers will total $4.50 million, with the expectation that continuing support at this level will be provided annually through FY 2007.

Earthquake Engineering Research Centers

The three Earthquake Engineering Research Centers (EERCs) focus on reducing earthquake losses, integrating research and education, and developing 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 2003, NSF provided nearly $6.0 million to three EERCs, which leveraged this support with $14 million from universities, three states, and industry. FY 2005 support is maintained at the FY 2004 level of $6.0 million.

Engineering Research Centers and Groups

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.

An additional $53 million in support from industry, other federal agencies, universities, and ten states leveraged NSF support of $65.72 million in FY 2003. There were 383 non-industry organizations from the U.S. and abroad and 522 firms involved in partnerships and collaborations in research and education

in these centers. In FY 2005, NSF will provide a total of $63.49 million, a decrease of $2.06 million from the FY 2004 Estimate. This funding supports 16 ongoing ERCs across a broad range of technologies.

Environmental Social and Behavioral Science Centers

From FY 1995 though FY 2003, NSF supported a consortium of Research Centers on the Human Dimensions of Global Change (HDGC). No such centers will be supported in FY 2004; however, following a new competition in FY 2005, NSF intends to continue providing support for centers that advance fundamental knowledge about environmental social and behavioral science, promote education and training at levels ranging from undergraduate to postdoctoral, and foster interdisciplinary and multidisciplinary research collaborations. NSF's FY 2005 support for three new Environmental Social and Behavioral Science Centers is expected to total $3.50 million, a $1.20 million increase (52.2 percent) from the level of $2.30 million that supported the HDGC Centers in FY 2003 during their final year of funding.

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 doubled to 66. In support of their long-term mission, some centers develop testbeds and include education and outreach components. Other centers are virtual centers that link, by high-performance networks, geographically separate investigators with individualized expertise or instrumentation. Some of these virtual centers foster research on distributed computing and applications. In FY 2005, NSF will fund approximately 80 ITR Centers at the level of $75.0 million, an increase of $1.0 million over the FY 2004 Estimate of $74.0 million for enhancements to existing centers.

Long Term Ecological Research Program

The Long Term Ecological Research (LTER) program is an NSF-wide Centers program that 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 facilitated by the LTER Network Office, enables regional, national and international synthesis.

In FY 2004 NSF is supporting 24 LTER sites that are representative of major ecosystems, including two sites in Antarctica. A significant development planned for FY 2005 is the expansion of the LTER network through the addition of up to threee new near-coastal marine sites, for a total of 27 sites in FY 2005. The LTER program has also led the development of the international long-term ecological research network (ILTER), enabling worldwide research collaborations among the U.S. sites and sites abroad.

NSF's FY 2005 Request for the LTER program is $22.82 million, an increase of $2.30 million over the FY 2004 Estimate.

Materials Centers

Materials Centers support interdisciplinary materials research addressing fundamental problems of intellectual and strategic importance. MRSECs include broad-based centers with diverse research agendas as well as more focused centers. The MRSECs feature cutting-edge materials research in areas such as polymers, biomimetic and biomolecular materials, nanoscale materials, electronic and photonic

materials, and superconducting and superhard materials. 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 $70 million in FY 2003. Approximately 28 MRSECs will be supported in FY 2005 at a total of $52.50 million. They include Materials Research Science and Engineering Centers (MRSECs) and International Materials Institutes (IMIs); beginning in FY 2004 they will include Partnerships for Research and Education in Materials (PREMs). IMIs are five-year awards aimed at supporting and stimulating cooperative activities in various areas of materials research and education between U.S. investigators and their colleagues worldwide. Three new IMIs were established in FY 2003, increasing to five or six in FY 2004 for a total of up to $3.60 million annually. This level of support will be maintained in FY 2005. In FY 2004, up to four Partnerships for Research and Education in Materials are proposed to be established at a total of about $2.40 million for 5 years. This level of support will be maintained in FY 2005. PREMs link minority-serving institutions with focused research groups, centers, and user facilities in materials research and support collaborations among them. The MRSECs have strong links to industry and other sectors; MRSECs, IMIs and PREMs all support research and educational partnerships with other institutions.

NSF's FY 2005 support for the Materials Centers totals $58.90 million, an increase of $2.34 million (4.1 percent) over the FY 2004 Estimate of $56.56 million.

Mathematical Sciences Research Institutes

The institutes provide a national resource for in-depth research in the mathematical sciences and for 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 2005, NSF will provide $16.60 million, an increase of $1.50 million (9.9 percent) over the FY 2004 Estimate of $15.10 million.

Nanoscale Science and Engineering Centers

As part of the multiagency National Nanotechnology Initiative, NSF funded six centers in FY 2001 and two centers focused on manufacturing at the nanoscale were established in FY 2003; an additional six centers are planned for FY 2004. Research at the nanoscale aims to advance the development of the ultra-small technology that will transform electronics, materials, medicine, environmental science 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 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 2005, NSF will provide continuing support to the eight centers at $33.79 million, an increase of $3.10 million (10.1 percent) over the FY 2004 level of $30.69 million.

National Consortium on Violence Research

The National Consortium on Violence Research (NCOVR), based at Carnegie Mellon University, 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 on increasing the participation of underrepresented groups in research on violence. NCOVR also seeks to facilitate collaborative methodological research and the

promotion of intellectual exchanges that cut across disciplines. NSF is providing about $1.0 million in support for the Consortium in FY 2005, unchanged from FY 2004.

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 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 is a key element of this program, and each center is expected to have a significant outreach and infrastructure component. In FY 2005, NSF will provide a total of $15.40 million for support of eight centers, an increase of $200,000 above FY 2004.

Plant Genome Virtual Centers

The Plant Genome Research subactivity supported twenty-nine Plant Genome Virtual Centers in FY 2003. These are multi-institutional networks where coordinated, multi-disciplinary teams pursue comprehensive, interdisciplinary research on the structure, organization and function of plant genomes relevant to economically important plants or plant processes.

Of the 29 centers supported in FY 2003, 18 were continuations or renewals of virtual centers created in previous years; 11 were newly established centers. The 29 centers involve 167 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 53 institutions in 28 States. International collaborators in 10 centers are involved in a number of areas of research including the potato, wheat, and model legume projects. NSF support for Plant Genome Virtual Centers in FY 2004 and FY 2005 will total $36.0 million each year.

Research Centers on the Human Dimensions of Global Change

NSF supported a consortium of Research Centers on the Human Dimensions of Global Change from FY 1995 through FY 2003. The goals of these centers were 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. FY 2003 was the final year of support for the two HDGC centers.

Science and Technology Centers

NSF's 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 $23 million in FY 2003.

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. NSF's FY 2005 Request for the STC program is $42.39 million for continuing support of eleven ongoing STCs and $30.0 million for support to establish six additional STCs from the most recent competition – for a total Request of $72.39 million.

Science of Learning Centers

NSF's investment in Science of Learning Centers (SLC), begun in FY 2003, builds 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 are organized around an integrated, unifying, multidisciplinary research focus or one that significantly advances disciplinary frontiers and is connected to educational, scientific, technological, and/or workforce challenges; consist of diverse teams at all organizational levels of the center; and establish partnerships with schools, industry, international collaborators, professional societies and/or other appropriate partners.

SLCs demonstrate an effective implementation strategy that aims to accomplish three principal goals: (1) advance 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 2005 support requested for the SLCs totals $20.0 million, up $120,000 over FY 2004, to support ongoing centers and about 20 new catalyst awards.

FY 2003 Estimates for Selected Centers
(Dollars in Millions)

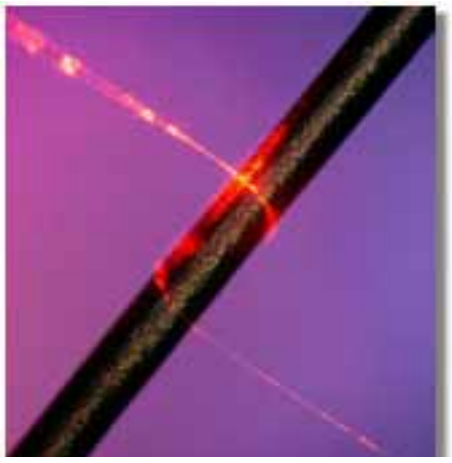
	FY 2003 Number of Participating Institutions	Number of Partners	Total NSF Support	Total Leveraged Support	Number of Participants
Chemistry Centers	47	15	$13	$1	610
Earthquake Engineering Research Centers	126	79	$6	$14	1,037
Engineering Research Centers and Groups	471	448	$66	$53	9,828
Long-Term Ecological Research Program	178	117	$18	$59	2,578
Materials Centers	83	330	$55	$70	4,950
Plant Genome Virtual Centers	53	9	$36	$6	2,160
Physics Frontiers Centers	14	12	$12	$2	328
Science and Technology Centers	79	211	$44	$23	2,140

Number of Participating Institutions: all academic institutions that 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.

HIGHLIGHTS OF RECENT ACCOMPLISHMENTS - IDEAS

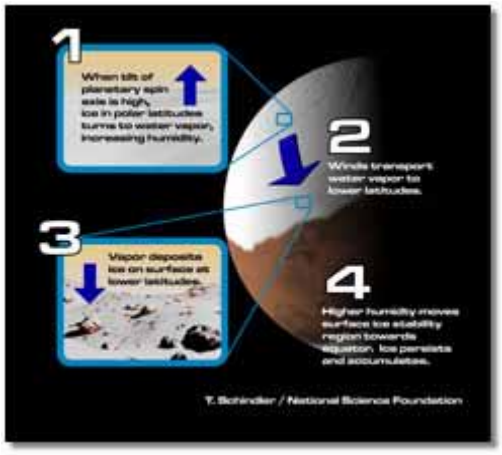
NSF investments in fundamental research provide support for cutting-edge research and education in many fields and help to maintain the nation's capacity to conduct research in science and engineering. Selected examples of accomplishments of NSF-supported investments are described below.

Researchers Develop Nanoscale Fibers That are Thinner Than the Wavelengths of Light They Carry. Researchers have developed a process to create wires only 50 nanometers (billionths of a meter) thick. Made from silica, the same mineral found in quartz, the wires carry light in an unusual way. Because the wires are thinner than the wavelengths of light they transport, the material serves as a guide around which light waves flow. In addition, because the researchers can fabricate the wires with a uniform diameter and smooth surfaces down to the atomic level, the light waves remain coherent as they travel. The smaller fibers will allow devices to transmit more information while using less space. The new material may have applications in ever-shrinking medical products and tiny photonics equipment such as nanoscale laser systems, tools for communications and sensors. Size is of critical importance to sensing – with more, smaller-diameter fibers packed into the same area, sensors could detect many toxins, for example, at once and with greater precision and accuracy.



A light-conducting silica nanowire wraps a beam of light around a strand of human hair. The nanowires are flexible and can be as slender as 50 nanometers in width, about one-thousandth the width of a hair. *Credit: L.Tong/Harvard Univ.*

Landscapes on Buried Glaciers in Antarctica's Dry Valleys Help Decipher Recent Ice Ages on Mars. Studies of the unique landscape in the Dry Valleys of Antarctica provide new insights into the origin of similar features on Mars and provide one line of evidence that suggests the Red Planet has recently experienced an ice age, according to a paper in the December, 2003 issue of the journal *Nature*. The distribution of hexagonal mounds and other features on the Martian surface at mid-latitudes similar to

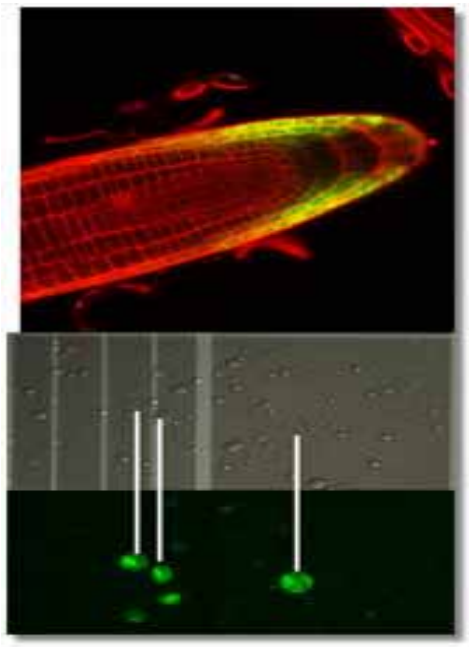


those in the Dry Valleys also supports previous scientific assertions that a significant amount of ice lies trapped beneath the Red Planet's surface.

This image describes how ice ages begin on Mars. (1) During periods of high obliquity (tilt of the planet's axis) the poles receive more direct sunlight, causing water vapor to evaporate from ice trapped there, increasing humidity. (2) Global winds transport the more humid air from polar latitudes to lower latitudes. (3) The water vapor is deposited on the surface as snow and frost. 4) Higher humidity at the surface makes ice more stable at lower latitudes, allowing it to accumulate, causing glaciation. *Credit: Trent L. Schindler / NSF*

Carbon nanotube tips for very high resolution Atomic Force Microscope (AFM) probes. The field of nanotechnology requires the development of new tools to probe devices on the nanometer scale. One of the few tools that is able to do this is the atomic force microscope (AFM). A critical factor that determines the resolution of such the AFM is the sharpness of the cantilever tip. An AFM cannot image surfaces at size scales smaller than the dimensions of the cantilever tip. Even the best tips currently available commercially have radii on the order of 20 nm. A natural candidate for making sharper AFM tips is a carbon nanotube. In addition to being extremely narrow (1.4 nm for single-walled nanotubes), nanotubes can be extremely long, so that surfaces with high relief features can be successfully imaged. Carbon nanotubes have been successfully mounted on commercial cantilever tips to obtain ultrasharp scanning probes. Images taken with this nanotube tip show substantial improvements in lateral resolution over images taken with a bare AFM tip. Other techniques are being developed to make ultrasharp tips with specific electronic and magnetic properties that will enable the study of a variety of surfaces with similar resolution.

Mustard-Root Map Breaks New Ground Tracking Gene Expression New 'global' technique a dividend of NSF's Arabidopsis 2010 effort. A new "gene expression" map is helping scientists track how a complex tissue ultimately arises from the blueprint of thousands of genes. Focusing on the root of a small flowering mustard plant, *Arabidopsis thaliana*, a research team led by Duke University biologist Philip Benfey created a detailed mosaic of cells showing where and when about 22,000 of the plant's roughly 28,000 genes are activated within growing root tissue. The results, announced in a recent issue of the journal *Science*, are the first to demonstrate "this level of resolution of gene expression on a global basis for any organism," said Benfey. The work, he said, serves as "a proof of principle" that similar approaches can be applied to other plant organs and other organisms.



The photos illustrate the first step in the root expression map technique. In the top photo, lateral root cap cells glow green because they share a common gene being expressed, one that has been marked with a gene that creates green fluorescent protein. In the middle micrograph, the plant cells have been treated with an enzyme that breaks down cell walls and disconnects the cells from each other. The bottom micrograph shows the same cells as in the middle micrograph, but with ultraviolet light applied to reveal only those with the GFP-marked genes active. These constitute the cell population glowing green in the top photo of the intact root. *All photos by Ken Birnbaum, New York University. Plant line shown in top photo created in lab of J. Hasseloff.*

The researchers collected hundreds of thousands of these specific cells. Using whole genome microarrays, also known as "gene chips," they then determined the genes expressed in these cells. The researchers typically detected about 10,000 genes in each cell population, and they reconstructed the gene-expression profile of the entire Arabidopsis root by repeating the process on virtually all cell types within it.

Chemists Crack Secrets of Nature's Super Glue. Researchers have discovered that iron in seawater is the key binding agent in the super-strong glues of the common blue mussel, *Mytilus edulis*. In addition to using the knowledge to develop safer alternatives for surgical and household glues, the researchers are looking at how to combat the glue to prevent damage to shipping vessels and the accidental transport of invasive species, such as the zebra mussel that has ravaged the Midwestern United States. National Science Foundation CAREER awardee Jonathan Wilker, Mary Sever and their colleagues at Purdue University announced their discovery in the January 12, 2004 issue of *Angewandte Chemie*.

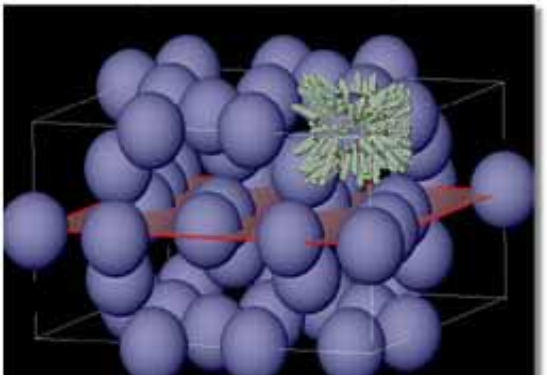
Common blue mussel (*Mytilus edulis*) hangs tough after a night adhering to otherwise "non-stick" Teflon®. *Credit: Jonathan Wilker of Purdue University*

Outcrop photograph of a melt-enhanced shear zone that developed along the base of an intruding batholith (shown in yellow in crustal column). *Credit: Photo courtesy of Keith Klepeis, University of Vermont*

Earth Scientists Forge New Understanding of Mountain-Building Dynamics. Understanding how mountains form is critically important – from volcanic eruptions to earthquakes to catastrophic mudslides, the geologic processes active in mountain belts affect human societies every day. Yet, even though mountains are on all continents and in all ocean basins, scientists still understand relatively little about the forces that interact to form and destroy mountains, how mountains change over time, and the relationship between mountains and Earth's climate. To better understand these dynamics, earth scientists are now integrating studies across traditional disciplinary boundaries. In research funded by NSF and recently published in the *GSA Today*, scientists have demonstrated a new way to integrate results from observations collected in the field with laboratory and experimental techniques. The team studied a mountain belt located in Fiordland, South Island, New Zealand.

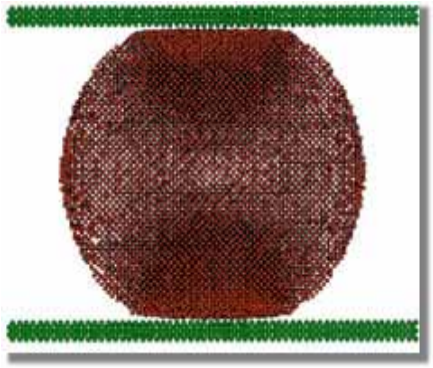
5-D Vision: Most useful metallic and ceramic materials are made up of many small crystals held together by grain boundaries. In many cases, these grain boundaries influence or even determine the performance of the material. To tell one type of grain boundary from another, the values of five distinct parameters must be specified. In other words, the space of boundary types is five-dimensional (5-D). In the past, "seeing" this 5-D space involved the accumulation of many tedious measurements. Because of this difficulty, researchers were forced to rely on simplified descriptions based on one or, at best, three parameters. The Materials Research Science and Engineering Center at Carnegie Mellon University has developed a statistical procedure for extracting 5-D information from fully automated observations of two-dimensional sections of grain boundary networks. This new characterization tool will facilitate the rapid analysis of grain boundaries in metals and ceramics and is expected to accelerate the design of a wide range of improved engineering materials.

New Molecular Self-Assembly Technique May Mimic How Cells Assemble Themselves. Researchers from the University of Pennsylvania and the University of Sheffield report in the February 21, 2003 issue of *Science* that they have created tree-like molecules that assemble themselves into precisely structured building blocks of a quarter-million atoms. Such building blocks may be precursors to designing nanostructures for molecular electronics or photonics materials, which "steer" light in the same way computer chips steer electrons.
electrons.



The spherical dendrimers form a liquid crystal material that has an unexpectedly complex lattice structure. The lattice has a repetitive unit cell of 30 spheres – more than 250,000 atoms – in a rectangular volume nearly 20 nanometers by 10 nanometers. C*redit: V.Percec, Univ. of Pennsylvania*

New Measurements Show Silicon Nanospheres Rank Among Hardest Known Materials. University of Minnesota researchers have made the first-ever hardness measurements on individual silicon nanospheres and shown that the nanospheres' hardness falls between the conventional hardness of sapphire and diamond, which are among the hardest known materials. Being able to measure such nanoparticle properties may eventually help scientists design low-cost superhard materials from these nanoscale building blocks. Up to four times harder than typical silicon – a principal ingredient of computer chips, glass and sand – the nanospheres demonstrate that other materials at the nanoscale, including sapphire, may also have vastly improved mechanical properties.



A 12-nm diameter silicon nanosphere, deformed by 2.3 nanometers in an atomistic simulation conducted by Mike Baskes of Los Alamos National Laboratory. At the top and the bottom the atoms are transformed into an amorphous state with no dislocations detected. Such simulations supported the hardness results measured experimentally by Bill Gerberich's team at Minnesota. *Credit: M.I. Baskes, Los Alamos National Laboratory*

Crystals on a Ball. Researchers have attacked a 100-year-old puzzle, and learned how a single layer of particles can pack on the surface of a sphere. In a discovery that is likely to impact fields as diverse as medicine and nanomanufacture, researchers have determined how nature arranges charged particles in a thin layer around a sphere. The leap forward in understanding this theoretical problem may help reveal structural chinks in the outer armor of viruses and bacteria (revealing potential drug targets) and guide engineers designing new molecules. On a flat surface, particles that repel each other will arrange themselves to create a stable energy state, eventually settling at vertices within a lattice of identical triangles much like billiard balls at the start of a game. Yet, for nearly a century, researchers studying spherical structures have known that a flat lattice cannot be simply wrapped around a sphere because the lattice of perfect triangles breaks down.

Since as early as 1904, when Nobel prize-winning physicist J.J. Thomson theorized about electron shells in atoms, researchers have wondered what structure the thin web of particles would choose, from among myriad possibilities, if wrapped around a sphere. In the March 14, 2003 issue of the journal *Science*, NSF researchers describe a major breakthrough in the puzzle, supported by experiments with water droplets and tiny, self-assembling beads. The researchers demonstrate how spherical crystals compensate for the curved surface on which they exist by developing "scars," defects that allow the beads to pack into place.

A rendered image of the protein shell that surrounds monkey cancer virus Simian Virus SV40 (the image is based on cryo-electronmicroscopy data). *Image Credit: VIrus Particle ExploreR*

Boundary Between Earth's Magnetic Field and Sun's Solar Wind Riddled with "Swiss Cheese" Holes. Magnetic fields explosively release energy in events throughout the universe, from experiments conducted in laboratories to huge outbursts within galaxies. On the Sun, these magnetic explosions are responsible for solar flares and ejections of material from the Sun's corona. Scientists have long debated whether the fast release of energy that occurs during "magnetic reconnection" is a smooth or turbulent process. Scientists funded by NSF have now used large-scale computer simulations, combined with direct observations from satellites, to show that the energy release is likely the result of turbulent processes. This knowledge may explain the effect of solar storms on Earth, from interruptions of satellite orbits to electrical outages in cities and towns. Satellite observations have shown that the boundary between Earth's magnetic field and the solar wind (known as the magnetopause) is riddled like Swiss cheese, with holes that may reach several miles in diameter. The holes move in the opposite direction of the prevailing electric current at speeds that can be faster than 1,000 miles per second, or 4 million miles per hour.

Aurora Australis--the Southern Lights--over the geodesic dome at the National Science Foundation's Amundsen-Scott South Pole Station. Like its more familiar counterpart, the Aurora Borealis--or Northern Lights, the phenomenon is caused by the solar wind passing through the upper atmosphere. *Photo Credit: Jonathan Berry, NSF*

"Raft" Down Sabino Canyon, an Ephemeral Stream in Arizona. Called Sabino Creek, this canyon stream in the Arizona desert exists for only part of every year. The canyon receives more than one million visitors each year from countries around the world who come to see a lush desert landscape fostered by the water that periodically courses through. Through the NSF-funded Center for Sustainability of Semi-Arid Hydrology and Riparian Areas (SAHRA), the U.S. Geological Survey and U.S. Forest Service, anyone with access to the Internet can visit Sabino Creek and learn about its unique attributes. To wend your way along this on-again, off-again watercourse, travel to: www.sabinocanyon.arizona.edu. The web site takes visitors to where Sabino Creek originates, floats them to where its water eventually ends, and shows what happens to the creek through the seasons – Sabino Creek flows only 293 days a year.

Sabino Creek, AZ: An ephemeral creek at its wettest. *Photo Credit: University of Arizona.*

Liberty Bell Web Portal Unites History and Technology. NSF website showcases all aspects of the Liberty Bell's move to its new home. The National Science Foundation (NSF), in collaboration with the National Park Service's Independence National Historical Park and MicroStrain, Inc., of Williston, Vermont, has created a new web portal to feature the history and technology surrounding the Liberty Bell's journey to its new home on October 9, 2003. Combining images, videos, and easy-to-read text, the website shows visitors details about the new sensor technology that will alert engineers and movers if the Bell's famous crack shows signs of spreading. Entitled "The Liberty Bell: Protecting an American Icon," the site also features the stories and legends that have made the Bell famous, and reveals the facts behind its crack and iconic symbolism.

African Ice Cores Reveal Prolonged Tropical Droughts. Ohio State University professors Lonnie Thompson and Ellen Mosley-Thompson led an international team of researchers to the summit of Mt. Kilimanjaro in 2000 to collect ice cores from glaciers at the summit in order to study tropical climate and the African monsoon system. What they discovered was completely astonishing. Through careful analyses, the team of researchers recreated an unprecedented and highly detailed record of three catastrophic droughts that plagued the region 8,300, 5,200 and 4,000 years ago. Glaciers at the top of Mt. Kilimanjaro in Tanzania began forming 11,700 years ago. Data from Kilimanjaro's ice cores reveal a wetter landscape in the region some 9,500 years ago than compared to today. Lake Chad, now the fourth largest body of water on the African continent with an area of 17,000 square kilometers, covered 350,000 square kilometers – an area larger than the modern day Caspian Sea. But beginning around 8,300 years ago, the ice cores reveal a climate of recurring and prolonged droughts, some lasting 300 years. While the causes of such climatic events are under active study by the Thompsons and colleagues, their recurrence is of major concern because seventy percent of the world's population now lives in the tropics and social systems can be dramatically stressed by climate events of the magnitude recorded in the ice.

Tools

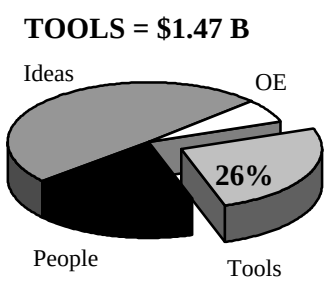
Broadly accessible, state-of-the-art S&E facilities, tools, and other infrastructure that enable discovery, learning and innovation.

The FY 2005 Request for Tools totals $1,472.08 million, a $104.19 million increase over the FY 2004 Estimate of $1,367.89 million. Operations and maintenance of multi-user facilities and research resources are funded through the Research and Related Activities (R&RA) and the Education and Human Resources (EHR) Accounts; major construction projects are funded through the Major Research Equipment and Facilities Construction (MREFC) Account.

NSF investments provide state-of-the-art tools for research and education, such as laboratory instrumentation and equipment, multi-user research facilities, distributed instrumentation networks and arrays, accelerators, telescopes, research vessels, aircraft, and earthquake simulators. In addition, investments in Internet-based and distributed user facilities, advanced computing resources, research networks, digital libraries, and large databases are increasing as a result of rapid advances in computer, information, and communication technologies. NSF's investments are coordinated with those of other organizations, agencies and countries to ensure complementarity and integration.

Tools Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Facilities	$538.17	$580.21	$685.57	$105.36	18.2%
Infrastructure & Instrumentation	336.66	341.52	344.93	3.41	1.0%
Polar Tools, Facilities and Logistics	252.96	250.24	254.15	3.91	1.6%
Federally-Funded R&D Centers	184.92	195.92	187.43	-8.49	-4.3%
Total, Tools Support	$1,312.70	$1,367.89	$1,472.08	$104.19	7.6%



Tools Long-Term Investment Categories: The four long-term investment goals that support the *Tools* strategic outcome are Facilities; Infrastructure and Instrumentation; Polar Tools, Facilities, and Logistics; and Federally-Funded Research and Development Centers (FFRDCs). They tie directly to NSF programs and budget resources and provide the framework for Program Assessment Rating Tool (PART) analysis of NSF performance.

FY 2005 Annual Performance Goal for Tools: NSF will demonstrate significant achievement for the majority of the following performance indicators related to the *Tools* outcome goal:

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

- Provide leadership in the development, construction, and operation of major, next-generation facilities and other large research and education platforms.
- Develop and deploy an advanced cyberinfrastructure to enable all fields of science and engineering to fully utilize state-of-the-art computation.
- Provide for the collection and analysis of the scientific and technical resources of the U.S. and other nations to inform policy formulation and resource allocation.
- Support research that advances instrument technology and leads to the development of next-generation research and education tools.

Means and Strategies for Success:

NSF utilizes the following means and strategies to achieve the strategic outcome goal of Tools and its associated long-term investment goals and annual performance goals.

- Support, through merit-based grants and cooperative agreements of sufficient size and duration, the most promising projects proposed by individual researchers and groups throughout the U.S.;
- Partner with other federal agencies, states, private organizations, national laboratories, or other nations to develop infrastructure by capitalizing on and leveraging the human and financial resources of each group;
- Operate an internal NSF capital planning process that encourages the development of innovative capabilities and meets the infrastructure needs of the U.S. community served by NSF;
- Develop and implement improvements for selecting, managing and overseeing large facility projects (cf. NSF Large Facility Projects Management and Oversight Plan, September 2001);
- Ensure that the breadth of infrastructure needs of the scientific community are examined regularly through workshops, panels, advisory groups, or other mechanisms;
- Provide broad support to the information technology community and others involved in innovative applications of cutting-edge IT tools for science and engineering;
- Upgrade the computation and computing infrastructure for all fields of science and engineering;
- Provide information on the status of the domestic / foreign science and engineering enterprise to inform science policy and priority setting;
- Develop and support a high-quality, balanced portfolio that invests in disciplines and fields, interdisciplinary research areas, and emerging opportunities; and
- Utilize the NSF core strategies of integrating research and education, promoting partnerships, and developing intellectual capital.

FACILITIES

Investments in the development, construction, and operation of state-of-the-art facilities and platforms that enable communities of researchers and educators to work at the S&E frontier.

To describe the life-cycle of a facility, the Foundation has adopted a set of distinct stages in its Facilities Management and Oversight Guide, found at http://www.nsf.gov/bfa/lfp/start.htm. These stages are: 1) Concept/Development – the phase during which the idea of a facility is articulated and project planning and design begins and is completed; 2) Implementation – including construction and/or acquisition, system integration, commissioning, testing, acceptance, transition to operations, and management of these efforts; 3) Operations and Maintenance – including the day-to-day work required to support and conduct research and education activities, to ensure that the facility is operating efficiently and cost-effectively, and to provide small- and intermediate-scale technical enhancements when needed to maintain state-of-the-art research capabilities; and 4) Renewal or Termination – the stage in which decisions regarding continued support of a facility are made. The information learned during the Operations and Maintenance

stage and through various reviews of the results of research and education activities and facility management is used to determine whether the facility will be renewed, upgraded, re-competed or terminated.

Facilities Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Academic Research Fleet	$65.20	$76.50	$83.20	$6.70	8.8%
Advanced Modular Incoherent Scatter Radar	14.00	11.00	12.30	1.30	11.8%
Cornell Electron Storage Ring	19.49	18.00	19.70	1.70	9.4%
Gemini	13.48	14.12	14.93	0.81	5.7%
Incorporated Research Institutions for Seismology	13.20	13.00	13.00	0.00	0.0%
Laser Interferometer Gravitational Wave Observatory	33.00	33.00	33.00	0.00	0.0%
Major Research Equipment & Facilities Construction[1]	184.82	189.88	278.22	88.34	46.5%
Atacama Large Millimeter Array Construction	29.81	50.70	49.67	-1.03	-2.0%
EarthScope: USArray, SAFOD, PBO	30.21	44.94	50.80	5.86	13.0%
High-Performance Instrumented Airborne Platform for Environmental Research (HIAPER)	13.00	0.00	0.00	N/A	N/A
IceCube Neutrino Observatory	25.75	41.75	33.40	-8.35	-20.0%
Large Hadron Collider	14.69	7.00	9.00	N/A	N/A
Network for Earthquake Engineering Simulation (NEES)	13.47	8.05	20.00	11.95	148.4%
Terascale Computing Systems	56.00	19.94	25.00	5.06	25.4%
National Ecological Observatory Network	0.00	4.00	16.00	12.00	N/A
Rare Symmetry Violating Processes		6.00	30.00	24.00	N/A
Scientific Ocean Drilling Vessel	1.90	2.10	41.35	39.25	N/A
Ocean Observatories Initiative		5.00	3.00	-2.00	-40.0%
Alaska Regional Research Vessel		0.40	0.00	-0.40	-100.0%
Nanofabrication (NNUN/NNIN)	6.05	12.45	13.86	1.41	11.3%
National High Magnetic Field Laboratory[2]	25.10	24.61	25.61	1.00	4.1%
National Superconducting Cyclotron Laboratory	15.65	15.65	16.65	1.00	6.4%
Ocean Drilling Program/Integrated Ocean Drilling Pgm	30.00	37.50	35.60	-1.90	-5.1%
Partnerships for Advanced Computational Infrastructure[3]	73.24	87.00	90.00	3.00	3.4%
Other Facilities[4]	44.94	47.50	49.50	2.00	4.2%
Total, Facilities Support	**$538.17**	**$580.21**	**$685.57**	**$105.36**	**18.2%**

[1]All MREFC projects are included in Facilities, except South Pole Station, which can be found under Polar Tools, Facilities and Logistics. Funding levels for MREFC projects in this table include initial support for operations and maintenance funded through R&RA as well as construction, acquisition and commissioning costs funded through MREFC. Information on all construction funds and activities for all MREFC projects can be found in the MREFC chapter.

[2]Support for the National High Field Mass Spectrometry Facility will be integrated into the National High Magnetic Field Laboratory in FY 2004, and has been included in the FY 2003 Actual.

[3]PACI includes cyberinfrastructure investment, which was previously listed as a separate item, in the amount of $20.0 million in FY 2004.

[4]Other Facilities includes support for the Network for Computational Nanotechnology, and other physics, materials research, ocean sciences, atmospheric sciences, and earth sciences facilities.

Program Assessment Rating Tool (PART) Evaluation: A PART on the Facilities program was completed to inform the FY 2005 budget decision-making process. Overall, PART assessment found Facilities to be an effective program. With respect to program purpose and design, the PART review found that the program has a clear purpose and addresses a specific need. NSF's Facilities program supports large, multi-user facilities, which allow researchers access to unique, state-of-the-art facilities that are necessary to advance U.S. capabilities required for world-class research. It also includes small facilities. This program addresses a critical need for tools to support basic research at universities and colleges. The program's design is free of major flaws that would limit its effectiveness or efficiency. NSF relies on the competitive merit review process, the NSF Program Officers in their oversight capacity, and independent, external Committees of Visitors (COVs) to ensure that facilities are effectively serving their intended communities, and to recommend changes to improve program effectiveness and efficiency. These measures ensure that supporting the acquisition and operation of infrastructure is the most efficient method of facilitating the science in question.

With respect to strategic planning, the program was found to have a limited number of long-term performance measures, with ambitious targets and timeframes, that focus on outcomes and meaningfully reflect the purpose of the program. It also has a limited number of annual performance measures, with ambitious targets, that demonstrate progress toward achievement of the long-term goals. Long-term outcomes for the Facilities program are external advisory committee (AC/GPA) findings of "significant achievement" that facilities enable discoveries or enhance productivity of NSF research or education communities and that NSF has partnerships to support and enable development of large facilities. Evaluations are conducted regularly at multiple levels in order to inform program improvements and influence program planning.

With respect to program management, Facilities was found to collect timely and credible performance information and to use it to manage the program and improve performance. Facilities was also found to effectively coordinate and collaborate with related programs, use strong financial management processes and obligate funds in a timely manner.

The program has demonstrated adequate progress in achieving its long-term goals, as qualitatively evaluated by external experts. Its performance compares favorably to other programs with similar purpose and goals.

The complete PART for Facilities and other assessed NSF programs may be found at the OMB website.

Annual Performance Goals for Facilities

FY 2005 Annual Performance Goal within Facilities – Facility Construction: For ninety percent of construction, acquisition and upgrade projects, keep any negative cost and schedule variances to less than 10 percent of the approved project plan. (This goal applies to all ongoing projects and those to be completed in FY 2005 that have a total project cost of at least $5.0 million.)

FY 2005 Annual Performance Goal within Facilities – Facility Operations: For ninety percent of operational facilities, keep scheduled operating time lost to less than 10 percent. (This goal applies to all NSF-supported facilities that received greater than $1.0 million in annual operations and maintenance support.) Results for the Facility Operations goal are shown below.

Results from Prior Years: FY 2003 was the first year for the construction goal.

Comparison with scheduled operating time.							
	FY 1999	**FY 2000**	**FY 2001**	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**
Goal	Keep operating time lost due to unscheduled downtime to less than 10 percent of the total scheduled operating time.	Keep operating time lost due to unscheduled downtime to less than 10 percent of the total scheduled operating time.	For 90 percent of facilities, keep operating time lost due to unscheduled downtime to less than 10 percent of the total scheduled operating time.	For 90 percent of facilities, keep operating time lost due to unscheduled downtime to less than 10 percent of the total scheduled operating time.	For 90 percent of operational facilities, keep scheduled operating time lost to less than 10 percent.	For 90 percent of operational facilities, keep scheduled operating time lost to less than 10 percent.	For 90 percent of operational facilities, keep scheduled operating time lost to less than 10 percent.
Result	Majority of facilities met goal. Inconclusive.	22 of 26 (85%) facilities met goal. Not achieved.	25 of 29 (86%) facilities met goal. Not achieved.	26 of 31 (84%) facilities met goal. Not achieved.	26 of 30 (87%) facilities met goal. Not achieved.	& &	& &

& = Data not yet available.

MAJOR MULTI-USER RESEARCH FACILITIES

A brief summary of Major Research and Equipment Facilities Construction (MREFC) projects can be found at the end of the Tools chapter. For a full discussion of these projects, please refer to the MREFC chapter.

Academic Research Fleet

Project Description: The Academic Research Fleet consists of 27 vessels in the University-National Oceanographic Laboratory System (UNOLS). These vessels range in size, endurance, and capabilities, providing NSF and other federally-funded scientists with a diverse fleet capable of operating in coastal and open ocean waters to conduct ocean science research. This project includes funding for ship operations, shipboard scientific support equipment, oceanographic instrumentation and technical services, ship acquisition and upgrade, and submersible support.

Principal Scientific Goals: The Academic Research Fleet serves as the main platform for the collection of data and testing of hypotheses in oceanography. Through use of these facilities, scientists contribute to advances made in such areas as climate, fisheries, and marine research.

Principal Education Goals: Vessels in the Academic Research Fleet permit shipboard training of future oceanographers. Through cruise participation, graduate and undergraduate students interact with scientists and marine technicians, enabling them to gain first-hand exposure to ocean science field research. Through recent technological innovations, research conducted at sea can be transmitted

remotely back to the classroom, broadening the educational impact of the vessels to a wider audience, including K-12 students.

Partnerships and Connections to Industry: The Academic Research Fleet is supported through an interagency partnership, principally with the National Oceanic and Atmospheric Administration (NOAA) and the Office of Naval Research (ONR) via a Memorandum of Understanding (MOU). NSF provides approximately 65 percent of the operating funds for the Fleet, while the remaining operating costs are divided proportionally among the other vessel users. NSF also coordinates with ship-operating and non-operating academic institutions through its connection with UNOLS.

Management and Oversight: NSF provides oversight to the Academic Research Fleet through cooperative agreements with each ship-operating institution and the UNOLS Office. In addition, NSF oversees the fleet through external review of proposals, site visits, ship inspections, and participation at UNOLS Council and subcommittee meetings by program managers. Several program managers within the Division of Ocean Sciences (GEO) are involved in the activities and overall oversight of the academic research fleet.

Management of an individual institution's ship-operating facilities varies with the size of the operation, but the core responsibility typically resides with the Director of the Institution, the Marine Superintendent (for all aspects of the facility), and the Ship's Captain (for at-sea operations). For larger multi-ship-operating facilities, a chief of marine technicians, schedulers and finance administrators may also be involved in facility management.

Current Project Status: NSF has supported this project for many years. Based on projected science requirements identified in recent reports and workshops, a fleet of vessels to support ocean science research will be needed far into the future. In coordination with the ocean science community, the Federal Oceanographic Facilities Committee (FOFC) recently developed and published a report on the long-range plan for renewal of the academic fleet. The FY 2005 Request for the Academic Research Fleet totals $83.20 million, an increase of $6.7 million over FY 2004 Estimate of $76.50 million. This increase will support the continued operation and implementation of the U.S. Academic Research Fleet. Also included are funds to continue planning for acquisition of a new deep submergence capability to replace the pioneering submersible ALVIN, and anticipated acquisition of a seismic research vessel to replace the aging R/V Maurice Ewing, which is in need of a significant refit. These new investments will open significant expanses of the deepest ocean to exploration, and bring greatly enhanced capability to map structures under the sea floor to U.S. researchers.

Funding Profile: All funding for the Academic Research Fleet to date has been provided through the R&RA Account.

Academic Research Fleet Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994	$2.13	$44.84	$46.97
FY 1995	0.60	45.69	46.29
FY 1996	1.51	41.52	43.04
FY 1997	0.02	40.86	40.88
FY 1998	0.37	40.23	40.61
FY 1999	0.00	43.28	43.28
FY 2000	0.26	45.11	45.36
FY 2001	2.30	56.60	58.90
FY 2002	2.30	59.60	61.90
FY 2003	3.00	62.20	65.20
FY 2004 Estimate	6.59	69.90	76.49
FY 2005 Request	13.23	70.00	83.23
FY 2006 Estimate	25.80	71.00	96.80
FY 2007 Estimate	18.80	72.00	90.80
FY 2008 Estimate	19.80	73.00	92.80
FY 2009 Estimate	20.80	74.00	94.80

NOTE: Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Implementation: From time to time, vessels require conversions or upgrades that go beyond the normal maintenance supported by operating costs. Funding decisions for conversions and upgrades are based on strong evidence of a scientific need. In recent years, the funding has provided for the conversion or upgrade of ships already in service whose age, configuration, or operating costs have impaired their usefulness. Planning for future years includes the replacement of ships that have reached the end of their useful life and replacing the capability for studies in the deep ocean as the aging ALVIN submersible reaches the end of its useful life. In December 2001, the FOFC of the National Oceanographic Partnership Program (NOPP) prepared a report titled *Charting the Future for the National Academic Research Fleet*, which defines a federal interagency renewal strategy for the national academic research fleet. Major upgrade expenditures indicated in implementation estimates in FY 2005 and out-years are for development of a new deep submergence vehicle, replacement of Regional Class ships and acquisition and reconfiguration of a seismic research vessel, consistent with community, National Research Council and FOFC reports.

- Operations and Maintenance: This includes funds for operating and maintaining the fleet, shipboard scientific support equipment, oceanographic instrumentation and technical services, and submersible support.

Renewal or Termination: Participation of each ship in the research fleet is through a cooperative agreement and is governed by the existence of an efficient schedule of scientific research cruises for that

ship, assessments of the continued fitness of the ship to conduct research at sea (as defined through the FOFC report above), and the ability of the operating institution to maintain cost effective operations.

Associated Research and Education Activities: NSF-funded researchers utilizing the fleet are supported through NSF's research programs and are subject to NSF's standard merit review process. The fleet supports approximately 2,500 users per year, which is based on the total number of individual researchers, postdoctoral candidates, graduate and undergraduate students, teachers, K-12 students and observers who have participated in cruises.

ARF Educational Participation

Year	K12	Undergrad	Graduate	Teachers[b]
FY 1994	12	194	503	12
FY 1995	0	228	596	5
FY 1996	1	179	454	6
FY 1997	0	177	453	0
FY 1998	1	193	550	29
FY 1999	0	331	476	7
FY 2000	0	251	389	8
FY 2001[a]	2	222	489	10

[a] Estimated number based on recent year average.

[b] Teachers include those participating in Teacher-At-Sea programs.

Science Support: NSF-supported researchers with grants totaling approximately $60.0 million in FY 2003 used the academic research fleet. Because of its collaborative nature and the interagency cooperation, which enables the operation of the academic fleet, NSF only pays for ship time used by NSF researchers.

Advanced Modular Incoherent Scatter Radar (AMISR)

Project Description: The Advanced Modular Incoherent Scatter Radar (AMISR) is a phased array incoherent scatter radar with unique features that allow efficient and cost-effective dismantling, shipping, and re-assembly. The radar comprises three identical antenna faces, each with approximately three times the sensitivity of the incoherent scatter radar currently operating in Sondre Stromfjord, Greenland. Each of the three fixed antenna faces is approximately 35 meters square with 4,096 radiating elements located on 128 separate panels. In addition to being relocatable, AMISR will provide the means for unique scientific observations via two significant features that have not been technically feasible in the past and that will greatly enhance the way observations and experimental campaigns are conducted. First, the phased-array concept will allow pulse-to-pulse beam steering, thus enabling three-dimensional "imaging" of electron density features in high signal-to-noise environments. Second, an incoherent scatter radar with a solid-state transmitter and no moving parts will permit both extended operating periods and true remote internet operation with virtual "control rooms" at universities world-wide.

Principal Scientific Goals: Long-term measurements of atmospheric parameters will help understand the processes influencing global change, and observations during solar storms will help understand and predict space weather, the primary goal of the multi-agency National Space Weather Program. There will also be strong synergy between AMISR scientific activities and the Center for Integrated Space Weather Modeling (CISM), one of six new NSF-funded Science and Technology Centers selected in FY 2002.

The AMISR systems at Poker Flat, Alaska, and Resolute Bay, Canada, will enable researchers to investigate fundamental issues of solar-terrestrial science including how the Earth is magnetically and electrically coupled to the Sun; what the structure and dynamics of the magnetosphere, ionosphere, and upper atmosphere are; and how the global energy flowing into the upper atmosphere at the pole flows to the equator. The scientific goals will change in the future as AMISR is deployed at other locations.

Principal Education Goals: The design for the AMISR is at the forefront of current radar, electronics, and signal processing technology. It uses advanced solid-state amplifiers that can be computer-controlled for maximum flexibility and ease of use. It will provide outstanding opportunities for students and young scientists and engineers to be involved with the development of the project and the operation of the instrument. The AMISR will be the first incoherent scatter radar designed for remote usage, allowing students and scientists to plan and configure experiments, and watch in real-time as the data is returned from remote sites. The web-based tools to be developed will make AMISR an excellent means to train the next generation of incoherent scatter radar specialists. The possibilities for new discoveries, combined with the ease of operation, will inspire hundreds of scientists from all over the globe to use the facility.

Partnerships and Connections to Industry: Manufacturing of the 12000 antenna element units is being done by Sanmina SCI, a global electronics contract manufacturing firm with headquarters in San Jose. The solid-state power amplifier for each of the units is being manufactured by Comtech PST, a company based in Melville, New York, that specializes in the production of amplifiers for commercial and military uses. The construction of the AMISR support structure and the foundation work at the sites in Alaska and Canada is being performed by VECO Corp., an Alaska-based company that specializes in management, engineering design and construction for the oil and power industries.

Management and Oversight: Overall project management and oversight is the responsibility of the program manager for Upper Atmospheric Facilities within the Division of Atmospheric Sciences. An Internal Management Team will be appointed with representatives from the Geosciences Directorate, Office of Polar Program, Budget, Finance and Award Management, and the Office of the General Council. As required in the cooperative agreement for the AMISR construction, SRI International has assembled a Technical Advisory Committee to provide technical oversight in the design and development of the AMISR system. SRI International has also written a Project Execution Plan that describes the AMISR work breakdown structure, management structure, project milestones, and final test and acceptance plan.

Current Project Status: The cooperative agreement for AMISR construction was approved on August 1, 2003, during the design for manufacturing phase of the project funded as a separate award for AMISR prototype development. As of the end of 2003, the design for manufacturing phase was completed and a pilot manufacturing run of 40 antenna element units was begun. The Technical Advisory Committee is scheduled to meet at SRI International in January to review the testing and performance of the 40 units. SRI International has begun environmental impact assessments for the site in Alaska and has submitted a formal request for frequency allocation from the National Telecommunications and Information Administration.

The AMISR is being developed in three stages. The first stage includes design and vendor selection based on experience SRI International has gained under previous NSF support to develop a working prototype. The second stage is the assembly of the first AMISR antenna face at the Poker Flat Research Range in Alaska, a site that is both scientifically interesting and logistically advantageous. The second and third antenna faces will then be assembled at the Resolute Bay Observatory in the Canadian Arctic. Future deployments will be determined on the basis of recommendations of a committee from the broader space science research community.

Milestones for the project are outlined below:

FY 2004 Milestones:
- Select SSPA Vendor
- Submit NTIA forms to NSF Spectrum Management Office
- Pilot run
- Final Design Verification
- Initiate panel and AEU manufacturing
- Poker Flat Activities:
  - Submit Poker Flat environmental assessment
  - Complete 48 panels with AEUs
  - Poker Flat site prep
  - Complete 40 panels with AEUs
  - Poker Flat foundation installation

FY 2005 Milestones:
- Poker Flat Activities
  - Complete 40 panels with AEUs
  - Poker Flat (1 face) constructed
  - Poker Flat system test complete and operational
- Resolute Bay Activities:
  - Face 1 and 2 foundation materials, support scaffolding and distribution shelters shipped to Resolute Bay via sealift
  - Complete 32 Panels with AEUs
  - Face 1 and 2 foundation constructed
  - Face 1 – 128 panels with AEUs shipped via sealift

FY 2006 Milestones:
Resolute Bay Activities:
- Face 1 erected
- Face 1 system complete and operational
- Complete 32 panels with AEUs
- Face 2 – 128 panels with AEUs shipped via sealift

FY 2007 Milestones:
- Resolute Bay Activities:
  - Face 2 constructed
  - AMISR system test complete
- Full operations begin

Funding Profile: The implementation phase of AMISR began late in FY 2003 with an initial allocation of $14.0 million. Additional implementation funding of $10.0 million per year for the next three years will be provided for a total of $44.0 million. Operations and maintenance will be initially funded at $1.0 million in FY 2004, increasing to $2.30 million in FY 2005. Funds allocated in previous fiscal years for prototype development are also shown in the table below.

AMISR Funding Profile
(Dollars in Millions)

	Planning, Design, Development	Acquisition, Construction, Commissioning	Management, Operations & Maintenance	Totals
FY 1999 & Earlier	$1.30			$1.30
FY 2000	1.30			1.30
FY 2001	1.00			1.00
FY 2002	3.40			3.40
FY 2003		$14.00		14.00
FY 2004 Estimate		10.00	$1.00	11.00
FY 2005 Request		10.00	2.30	12.30
FY 2006 Estimate		10.00	2.40	12.40
FY 2007 Estimate			2.50	2.50
FY 2008 Estimate			2.60	2.60
FY 2009 Estimate			2.70	2.70
Totals	**$7.00**	**$44.00**	**$13.50**	**$64.50**

NOTE: A steady state of about $2.4 million in operations support is expected to occur in or about FY 2008. The expected operational lifespan of this project is at least 20 years, beginning in FY 2007. Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Concept/Development: Initial R&RA funding for AMISR began in 1999 with an award to SRI International to develop the design of the antenna element units. Subsequent funding was provided for building 32 engineering prototype units that were assembled into a panel for testing at the SRI field site near Stanford University and the U. S. Air Force antenna test facility in Ipswich, Massachusetts. The Concept/Development phase concluded with the competitive source selection of Sanmina SCI and two years of design for manufacturing activities involving close interaction between Sanmina and SRI engineers.

- Implementation: FY 2004 funding in the amount of $10.0 million is being used to build the first AMISR face at Poker Flat, Alaska. The 4,000 antenna element units will be manufactured over the next twelve months. Site preparation at Poker Flat will begin late spring 2004. The antenna elements will be assembled onto panels by SRI International as they are received from the manufacturer. The assembled panels will be shipped to Alaska early in 2005 for integration and testing. This schedule will repeat for the two remaining faces to be deployed at Resolute Bay—the first in 2006 and the second in 2007.

- Operations and Maintenance: SRI is currently preparing a proposal for the initial operation and maintenance of the AMISR systems at Poker Flat and Resolute Bay. Operation and maintenance of the face at Poker Flat will be accomplished in collaboration with personnel at the Geophysical Institute, University of Alaska. Other participating institutions include Stanford University, MIT, and the University of Saskatchewan. Additional instrumentation for the two facilities will be funded through the R&RA grants programs within ATM.

Future Science Support: In addition to the operations support indicated above, AMISR research and education programs will be funded through the Aeronomy, Magnetospheric Physics, and Upper Atmospheric Facilities core programs within the Upper Atmospheric Research Section. The combined annual support level for this research is estimated to be about $5.0 million.

Cornell Electron Storage Ring (CESR)

Project Description: The Cornell Electron Storage Ring (CESR) supports research in elementary particle physics as well as in accelerator physics and superconducting radio frequency (RF) applications. CESR is an electron-positron collider that has provided important knowledge of the properties of the b-quark. Cornell University is now modifying CESR and the associated particle detector (CLEO) for operation over the energy range 1.5 GeV to 5.6 GeV per beam, to address high-priority physics questions relating to the c-quark and possible gluon states that cannot be addressed elsewhere. The transformed collider and detector will be named CESR-c and CLEO-c, respectively.

The materials research community at the Cornell High Energy Synchrotron Source (CHESS) also uses the CESR facility. CHESS is a high-intensity high-energy X-ray source that uses the synchrotron light given off by the charged particles, both electrons and positrons, as they circulate at nearly the speed of light around CESR. As a user facility, CHESS provides state-of-the-art synchrotron radiation facilities for research in Physics, Chemistry, Biology, and Environmental and Materials Sciences.

Principal Scientific Goals: CESR-c and CLEO-c will explore a large set of critical weak and strong interaction phenomena, knowledge of which is either lacking or fragmentary. These in turn will drive theoretical advances that will both extend and enable the full program of physics targeted by many new-generation detectors, such as those at Stanford Linear Accelerator Center (SLAC**)**, Fermilab, and the Large Hadron Collider (LHC), and will lay the foundation for strong interaction theory to meet the requirements of future physics beyond the Standard Model.

Principal Education Goals: To support and enhance Ph.D. level graduate education, postdoctoral research experience, research experiences for undergraduates, and research experiences for K-12 science teachers. Engendering excitement in science among young children will be a focus for strengthening K-12 engagements. An important component of that effort will be the participation of CLEO and CESR graduate students in school science classrooms.

Partnerships and Connections to Industry: CESR staff is transferring CESR Superconducting RF (SRF) technology to industry. Two new industrially fabricated SRF cavity systems have been acquired in order to shorten CESR bunch length with higher voltage. Through a license arrangement with Cornell, the ACCEL Corporation has manufactured two superconducting RF sources to power synchrotron light sources. They have been tested and installed in CESR to replace two older, lower gradient modules. Also some of the CHESS users are from industry, including: pharmaceutical corporations (Rib-x Pharmaceuticals) and the research arms of Eastman Kodak, Xerox and General Motors. Some medical institutions also make use of CHESS (Dana Farber Cancer Institute, Boston Biomedical Research Institute, and Memorial Sloan-Kettering Institute).

Management and Oversight: CESR-c is managed by the Director of the Laboratory for Elementary Particle Physics (LEPP) at Cornell, an Assistant Director, and an Associate Director for Accelerator Physics. The CLEO-c experiment is the sole CESR-c experiment in particle physics, a collaboration consisting of users from about 20 U.S. institutions. CESR-c management interacts with the CLEO-c collaboration through the collaboration spokesperson and executive board as needed, and there are monthly meetings of the collaboration that include CESR-c management.

NSF oversight by Physics Division (MPS) staff occurs through annual site visits. Technical review of the award involved panel evaluation of the CESR-c proposal, and a site visit by NSF staff and external reviewers. The oversight process includes annual financial reports and program reports to the NSF and an annual review by a Program Advisory Committee of outside physicists reporting to the Laboratory Director and NSF. A comprehensive review will be held midway through year three of a five-year award.

Current Project Status: A five-year Cooperative Agreement was initiated in FY 2003. Cornell University will modify the CESR colliding beam accelerator and the CLEO particle detector as mentioned above. In addition to the particle physics program, a vigorous program of accelerator science and technology development for accelerator concepts for the future will continue. CESR-c will also provide intense X-ray beams for the program in X-ray science at CHESS. The particle physics program and X-ray science program will now begin to use different accelerator energies, requiring the two programs to operate in different time periods. CHESS is supported through the Materials Research Subactivity (MPS), the Biological Sciences Activity, and by the National Institutes of Health. The FY 2005 Request for CESR totals $19.70 million, an increase of $1.70 million from the FY 2004 Estimate of $18.0 million. It is expected that the CESR-c and CLEO-c projects will cease at the end of the five-year period.

Funding Profile: The FY 2003 – FY 2009 estimated funding for CESR-c and CLEO-c will ensure completion of the elementary particle physics program and provide sufficient time for the particle physics group and the CHESS facility to plan their future activities. All funding for CESR to date has been provided through the R&RA Account.

CESR Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994		$17.40	$17.40
FY 1995	$10.90	12.50	23.40
FY 1996	8.70	14.90	23.60
FY 1997	6.50	14.00	20.50
FY 1998	6.20	12.40	18.60
FY 1999	3.20	16.30	19.50
FY 2000		19.49	19.49
FY 2001		19.49	19.49
FY 2002		19.49	19.49
FY 2003		19.49	19.49
FY 2004 Estimate		18.00	18.00
FY 2005 Request		19.70	19.70
FY 2006 Estimate		21.00	21.00
FY 2007 Estimate		20.50	20.50
FY 2008 Estimate		10.00	10.00
FY 2009 Estimate		0.00	0.00

NOTE: Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Implementation: These figures reflect an upgrade to CESR in the FY 1995 through FY 1999 time period to allow the accelerator to produce higher luminosity beams and to CLEO to allow the detector to operate and take data under the higher luminosity conditions.

- Management and Operations: The facility operates about 5,500 hours per year for CLEO research and for accelerator physics and development. Maintenance is provided through a weekly 8-hour shift and through two or three, 3-week shut-downs for maintenance of the accelerator, superconducting RF, helium refrigerator, vacuum system, beam lines for CHESS, power systems, and other ancillary systems. Approximately 30 percent of the CESR funding is directed toward in-house research (both experimental elementary particle physics and accelerator physics) with the remainder used to operate and maintain the facility. The funding profile above includes minor detector and accelerator changes that are essential to completion of the scientific program before FY 2009.

Associated Research and Education Activities: Cornell continues to be active in outreach:

- LEPP holds staff workshops in Diversity Awareness;
- LEPP has conducted "Expanding Your Horizons" workshops for ~100 middle school girls over the last three years, involving 7 female graduate students and 1 female faculty member. The most recent workshop, in April 2003, hosted 18 middle school girls;
- Approximately 200 high school physics teachers received tours, lesson plans, and/or presentation materials, along with educational videos on particle physics via outreach events from April to November 2003;
- Approximately 60 elementary school students, 45 middle school students and 185 high school students were involved in activities hosted by LEPP. Over 300 people toured the Wilson Laboratory facility during this time frame;
- LEPP hosted a three-day workshop in June 2003 entitled "Exploring Physics First". Workshop participants exchanged ideas and information about the philosophy of teaching physics first in the high school science sequence;
- In August, LEPP sponsored a science booth at the New York State Fair entitled "Electrifying Experiments!" Over 500 youths and adults stopped by to participate in hands-on physics activities;
- LEPP personnel participate in "Saturday Academy," a group of ~25 minority grade and high school students meeting monthly
- LEPP sponsors a monthly Visiting Scientist series at a rural elementary school where 36 percent of the children are eligible for free school lunches;
- LEPP conducts an "Atoms for Kids" program at two rural elementary schools where ~30 percent of the students are similarly eligible for free school lunches; and
- The laboratory trains graduate students in accelerator physics and has supported the development of superconducting radio frequency accelerating cavities.

Science Support: Approximately $3.0 million is provided annually by NSF in support of separate awards to external users of the CESR/CLEO facility. DOE provides a similar amount in support of awards to individual investigators and groups. In addition, $600,000 is provided in a separate award to Cornell in support of theoretical elementary particle physics research.

About 200 physicists from 22 universities have built and are operating the CLEO detector to study the products of the electron-positron collisions. CESR is a national user facility and the current CLEO-c collaboration includes more than 150 researchers from 25 U.S. and foreign institutions.

The CHESS facility is used by the materials research community, with typically 600-700 users per year.

Gemini

Project Description: The Gemini Observatory consists of two 8-meter telescopes, one in the northern hemisphere, in Hawaii, and one in the southern hemisphere, in Chile. The Hawaiian telescope is optimized for infrared observations and is located on Mauna Kea at an altitude of 4200 meters. The telescope in Chile is located on Cerro Pachon, an outstanding photometric site, at an altitude of 2700 meters. This siting of the two telescopes assures complete coverage of the sky to complement the observations from space-based observatories, and provides access to the center of our own Galaxy as well as the Magellanic Clouds, our nearest galactic neighbors. Both telescopes are designed to produce superb image quality and both use sophisticated adaptive optics technology to compensate for the blurring effects of the Earth's atmosphere. The Observatory is an international collaboration with the United Kingdom, Canada, Australia, Chile, Argentina and Brazil.

Principal Scientific Goals: Astronomers need to resolve important questions about the age and rate of expansion of the universe, its overall topology, the epoch of galaxy formation, the evolution of galaxies once they are formed, and the formation of stars and planetary systems. The new generation of optical/infrared telescopes with significantly larger aperture (8-meter diameter) than existing instruments provide better sensitivity and spectral and spatial resolution. Technological advances in a number of key areas of telescope construction and design allow these instruments to take advantage of the best performance the atmosphere will allow.

Principal Education Goals: The Gemini telescopes will play a central role in the education and training of U.S. astronomy and engineering students. An estimated 20% of the projected 400 users per year will be students from the partner countries. Gemini is also providing a focus for public outreach and high school student training in all the partner countries, including the development of "sister city" arrangements between Hilo, Hawaii and La Serena, Chile involving students and teachers at high school and elementary school levels.

Partnerships and Connections to Industry: Gemini is an international partnership with the United Kingdom, Canada, Australia, Chile, Argentina, and Brazil. Construction of the telescopes and their instrumentation has involved a large number of industrial concerns in a number of partner and non-partner countries. These have involved firms in large and/or complex optical systems, aerospace industries, electronics and engineering firms, etc. Continued involvement of such industries is part of the instrumentation and facilities renewal activities included in the operating budget of the Gemini Observatory.

Management and Oversight: The project is governed by the Gemini Board, which was established by the International Gemini Agreement signed by the participating agencies. NSF serves as the Executive Agency for the seven-nation partnership, carrying out the project on their behalf. Programmatic management has been the responsibility of the Staff Associate for Gemini in the Division of Astronomical Sciences (MPS), assisted by an internal Project Advisory Team with representation from Office of the General Counsel, Office of Legislative and Public Affairs, Budget, Finance and Award Management, Division of Financial Management, and the Office of International Science and Engineering. During construction and oversight, a committee of outside experts regularly reviewed progress and reported to the partnership. With the start of scientific operations, the Gemini Board has established an independent Visiting Committee that will advise on the operation of the Observatory. Gemini is managed by Associated Universities for Research in Astronomy (AURA), Inc on behalf of the partnership through a cooperative agreement with NSF. AURA conducts its own management reviews through standing oversight committees. The current cooperative agreement expires in FY 2005. Under the terms of the international agreement, the partnership will determine whether to compete the management of the Observatory at that time.

Current Project Status: Construction of both telescopes is complete and science operations have begun at both sites. Commissioning of facility instruments continues at both telescopes. The Chilean partner in Gemini, CONICYT, has had a perennial problem paying operations contributions, though they have completed the construction payments in full. The astronomical community in Chile feels a far greater need to develop astronomy within the country than a need for more observing time. Gemini South is on Chilean soil and the conditions of exemption from taxes and duties under which Gemini operates in Chile are very advantageous.

CONICYT proposed that the Gemini partners effectively return the equivalent of Chile's construction payment to CONICYT to be used as a fund whose proceeds would be used to develop astronomy. In a "cooperative agreement" CONICYT remains a partner and returns to the partnership the 5 percent observing time on both telescopes that they had been entitled to as a result of paying 5 percent of the capital and operating costs. This proposal has been accepted by the Gemini Board and has been discussed with the National Science Board's Committee on Programs and Plans. Within the partnership there is agreement that the U.S. will assume 52.5 percent of the Chilean share, Australia 30 percent, Canada 15 percent, and Brazil the remaining 2.5 percent. A schedule of payments has been constructed that results in the payment of the full capital return by the end of 2005.

The FY 2005 Request totals $14.93 million, an increase of $810,000 over the FY 2004 Estimate of $14.12 million. Included in this increase is $1.0 million for partial return of the U.S. share of Chilean capital.

Funding Profile: The total NSF contribution to the construction of the Gemini telescopes is $92.0 million, representing a 50% share of the total project cost. Experience gained during the construction and integration of the Hawaii telescope allowed for an accelerated schedule in Chile.

Gemini Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Grand
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	Total
FY 1994 & Earlier	$12.00		$47.00				$59.00
FY 1995				$41.00			41.00
FY 1996					$3.82		3.82
FY 1997					5.32		5.32
FY 1998				4.00	5.72		9.72
FY 1999					8.05		8.05
FY 2000					8.38		8.38
FY 2001					8.66		8.66
FY 2002					12.50		12.50
FY 2003					13.48		13.48
FY 2004 Estimate[1]					14.12		14.12
FY 2005 Request[1]					14.93		14.93
FY 2006 Estimate[2]					16.53		16.53
FY 2007 Estimate[2]					18.34		18.34
FY 2008 Estimate[3]					20.00		20.00
FY 2009 Estimate[3]					20.00		20.00
Subtotal, R&RA	$12.00		$47.00		$169.85		$228.85
Subtotal, MREFC		$0.00		$45.00		$0.00	$45.00
Total, Each Phase		**$12.00**		**$92.00**		**$169.85**	**$273.85**

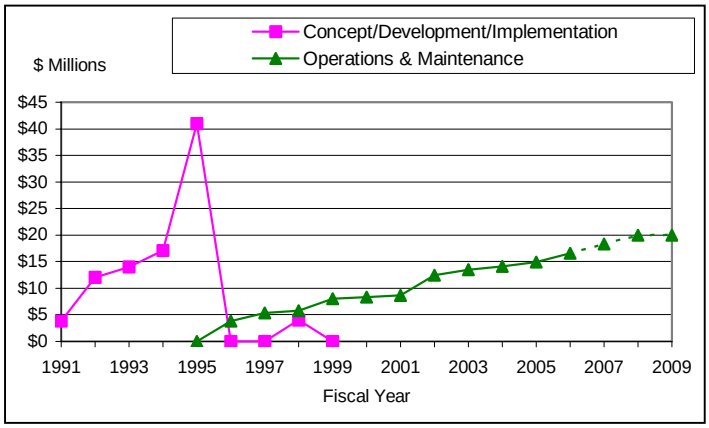
[1] FY 2004 and FY 2005 funding includes the cost of the Chilean capital return, consistent with the U.S. assumption of a portion of the Chilean share.

[2]The current cooperative agreement ends in FY 2005. The figures for FY 2006 and onward reflect the anticipated growth of the operating budget and funds for second generation instrumentation being used by the Observatory and the Gemini Board for planning purposes. They will be updated as new information becomes available. The anticipated lifetime of the Observatory is 25 years.

[3]A steady state of about $20.0 million annually is anticipated for the U.S. share of operations beginning in FY 2008.

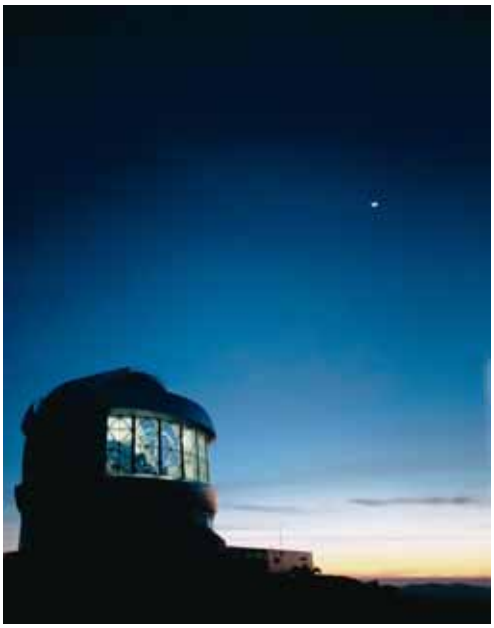
Information pertaining to the data in the table is included below.

- Concept/Development: Funds represent estimated U.S. investments in the development of mirror technologies for a new generation of telescopes, as recommended by the National Academy Report "Astronomy and Astrophysics for the 1980's." Three different mirror technologies were explored. These investments in technology development contributed to the plans for Gemini, as well as to other new telescopes that advance research in astronomy.



- Implementation: Gemini construction was initiated in FY 1991, before establishment of the MREFC Account in FY 1995. The $92.0 million obligated for Gemini construction is the U.S. share of the total cost ($184.0 million) for the two telescopes, with the balance provided by international partners.

- Management and Operations: Funding ramped up as the telescopes approached initial operations. Beginning in FY 2002 operations included the U.S. assumption of a portion of the Chilean share of operations costs, as agreed by the international partners. The funds provide additional observing time to the U.S. astronomy community while Chile maintains a share of observing time as host country. Under this adjustment, NSF supports just over 50% of management, operations and maintenance. In FY 2004-2005, costs reflect Chilean capital return, consistent with U.S. assumption of a portion of Chilean share.



The Gemini South Telescope readying for nighttime observations. *Credit: Gemini Observatory.*

Renewal or Termination: The five-year cooperative agreement for the support of Gemini operations expires in FY 2005. Under the terms of the international agreement, the partnership will determine whether to compete the management of the Observatory at that time.

Associated Research and Educational Activities: The public information and outreach office at Gemini carries out local outreach to schools, teachers, and the general public, as well as coordinates and serves as a liaison for the outreach efforts of partner countries. They also provide media services and web-based resources.

Science Support: Along with direct operations and maintenance support for Gemini, NSF will support research performed at the facility, through ongoing research and education programs. The annual support for such activities is estimated to be about $5.0 million, once the facility reaches full operations.

Incorporated Research Institutions for Seismology (IRIS)

Project Description: IRIS is a consortium of 101 U.S. universities and not-for-profit institutions with research and teaching programs in seismology. IRIS operates a distributed national facility for the development, deployment, and operational support of modern digital seismic instrumentation to serve national goals in basic research in the earth sciences, in earthquake research, and in nuclear test ban monitoring. IRIS is organized in four major program elements: (1) The Global Seismographic Network (GSN) currently consists of a global deployment of 136 permanently installed digital seismic stations; (2) The Program for Array Seismic Studies of the Continental Lithosphere (PASSCAL) manages a pool of portable seismometers which are made available to the seismology research community for scheduled regional and local scale studies; (3) The IRIS Data Management System (DMS) provides the national and international seismic research community with timely access to data from the GSN and PASSCAL; and (4) The IRIS Education and Outreach (E&O) Program which enables audiences beyond seismologists to access and use seismological data and research for educational purposes, including teacher workshops, student internships, museum exhibits, educational materials, and programs for under-resourced schools.

Principal Scientific Goals: The Earth's interior remains a major scientific frontier holding the key to understanding the origin of the planet. Recent developments in seismic sensor design, and the acquisition, transmission and storage of data have resulted in dramatic improvements in the resolving power of seismic imaging of the interior. Earthquake research, including rapid and accurate location and characterization of the earthquake source, its magnitude and a better understanding of the physical process involved, has also benefited greatly from recent technical advances. The IRIS facility serves the research needs of the national and international seismology community by making available state-of-the-art designs in seismic sensors and data acquisition systems. In addition to its role in providing the observational data essential for basic research in geophysics and earthquake dynamics, IRIS plays a significant role in seismic monitoring of the Comprehensive Test Ban Treaty and in bringing seismology to students and the public through the activities of its Education and Outreach program.

Principal Education Goals: The IRIS Education and Outreach (E&O) Program enables audiences beyond seismologists to access and use seismological data and research for educational purposes. E&O activities include teacher workshops, student field internships, museum exhibits, educational materials, the development of classroom seismic stations, and programs for under-resourced schools. E&O projects serve not only to advance public understanding of geoscience, but also to foster improved understanding of the scientific process and scientific data.

Connections to Industry: The use of IRIS PASSCAL instruments for investigations of the shallow crust provides opportunities for collaboration with the petroleum exploration industry. Many students involved in these experiments receive training in techniques that prepare them for careers in the exploration industry. In a broader sense, IRIS continues to closely collaborate with industry in development of seismic instrumentation and software.

Partnerships: IRIS is heavily involved in partnership activities, many international in nature. Installation and operation of the Global Seismographic Network (GSN) has put IRIS in contact with scientists as well as government and non-government organizations all over the world. Many international IRIS GSN stations are designated as the official stations for nuclear test ban monitoring in their host countries. International teams of scientists organize most PASSCAL projects overseas. The IRIS facilities also are multi-use resources for other government agencies that have responsibilities for development of a nuclear test-ban monitoring capability and for monitoring of global seismicity. For these purposes, agencies in partnership with NSF have provided substantial support to IRIS for accelerated development of the GSN (Department of Defense), shared operation and maintenance of the GSN (U.S. Geological Survey), and accelerated development of the PASSCAL instrument pool (Department of Energy).

Management and Oversight: IRIS is incorporated as a nonprofit consortium representing practically all U.S. university and nonprofit organizations with research and teaching programs in seismology. Each member institution appoints a representative who serves with full voting privileges on the IRIS Board of Directors. However, all IRIS program and budget decisions are made by an eight-member Executive Committee, elected by the Board of Directors to three-year terms. These decisions are made after consultation with the IRIS advisory committees (the four standing committees for each of the four IRIS programs and additional *ad hoc* working groups appointed for special tasks). The Executive Committee appoints a president of IRIS to a two-year term. The president is responsible for IRIS operations, all of which are managed through the IRIS Corporate Office.

The Division of Earth Sciences (GEO), through its Instrumentation & Facilities Program (IF), provides IRIS with general oversight to help assure effective performance and administration. The Program also facilitates coordination of IRIS programs and projects with other NSF-supported facilities and projects and with other Federal agencies and evaluates and reviews the scientific and administrative performance of IRIS.

Current Project Status: The IRIS consortium was founded in 1984 by 26 universities in response to recommendations in a report issued in 1983 by the Committee on Science, Engineering, and Public Policy (COSEPUP) of the National Academy of Sciences. This report urged that "NSF act as overall coordinator and lead agency for funding a global digital seismic array and that the operation be planned and overseen by a university consortium." During the last fifteen years, with support from the Foundation and federal partners, the IRIS consortium has grown to 101 full-member (voting) U.S. universities that operate core research facilities consisting of a Global Seismographic Network (GSN), the Program of Array Seismic Studies of the Continental Lithosphere (PASSCAL), and a Data Management System (DMS). During the last cooperative agreement period, IRIS initiated a new Education and Outreach (E&O) program. The FY 2005 Request for IRIS totals $13.0 million, level with the FY 2004 Estimate.

Funding Profile: All funding for IRIS to date has been provided through the R&RA Account.

IRIS Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994	$1.67	$5.64	$7.31
FY 1995	2.03	5.52	7.55
FY 1996	5.61	2.39	8.00
FY 1997	2.32	8.83	11.15
FY 1998	1.27	9.76	11.03
FY 1999	0.69	10.77	11.46
FY 2000	0.46	11.16	11.62
FY 2001	1.90	11.38	13.29
FY 2002	1.93	11.00	12.93
FY 2003	2.00	11.20	13.20
FY 2004 Estimate	2.00	11.00	13.00
FY 2005 Request	2.00	11.00	13.00
FY 2006 Estimate	2.30	12.00	14.30
FY 2007 Estimate	2.40	12.20	14.60
FY 2008 Estimate	2.50	12.30	14.80
FY 2009 Estimate	2.60	12.40	15.00

NOTE: Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Implementation: Implementation includes funds for major equipment purchases (data recorders and seismometers) for the PASSCAL Instrument Center in Socorro, NM and the Global Seismographic Network (GSN).

- Operations and Maintenance: This category includes funds to support the IRIS corporate office in Washington, DC, including the Education & Outreach Program (E&O); the PASSCAL

Instrument Center in Socorro, NM; the Data Management System (DMS) in Seattle, WA; and the Global Seismographic Network (GSN). IRIS conducts no "in-house research."

Renewal or Termination: Two reviews have been stipulated in the new NSF cooperative agreement with IRIS: (1) an in-depth study by IRIS of the operation, personnel, and instrument costs, and support of the Global Seismographic Network (GSN), in collaboration with the USGS, representatives of the Federation of Digital Seismic Networks (FDSN), and GSN network operators by July 1, 2003; and (2) an NSF review of IRIS management in coordination with IRIS and its appropriate governance committees, to be completed by July 1, 2004. This latter review will provide more information for the basis of the decision to either allow the submission of a renewal proposal or to recompete the operation of this facility.

Associated Research and Education Activities: IRIS sponsors an active education and outreach program, which touches a vast number of individuals annually. There are currently 471 schools and individuals on the IRIS mailing list, and 25 K-12 schools with IRIS seismographs. The website visitors' data in the table below indicate yearly sums of unique visitors, and the K-12 students' number assumes each teacher interacts with 80 students per year. IRIS also holds a number of workshops each year for K-12 and college students; in FY 2002, 5 such workshops were held.

IRIS Participation

Year	K-12	Undergrad	Graduate	Teachers	Faculty	Museum Display Visitors	Posters Distributed	Website Visitors
FY 1998	3400	2	28	43		500,000	2,000	
FY 1999	5300	9	22	23	35	2,000,000	5,000	
FY 2000	6900	2	30	20	20	9,000,000	4,000	280,000
FY 2001	12000	2	33	65	25	9,000,000	3,000	280,000
FY 2002	18000	6	24	86	16	9,000,000	2,000	410,000

Science Support: The EAR/Geophysics and Continental Dynamics Programs and the OCE/Marine Geology & Geophysics Program provide most of the funds for NSF-sponsored research, totaling approximately $15.0 million per year. Funds permit deployment of PASSCAL instruments and use of GSN data stored at the DMS to solve major earth science problems.

Laser Interferometer Gravitational Wave Observatory (LIGO)

Project Description: Einstein's theory of general relativity predicts that cataclysmic processes involving super-dense objects in the universe will produce gravitational radiation that will travel to Earth. Detection of these gravitational waves is of great importance, both for fundamental physics and for astrophysics. LIGO, the most sensitive gravitational wave detector ever built, comprises two main facilities, one in Livingston Parish, LA and one in Hanford, WA. At each facility, a large vacuum chamber, with two 4-km arms joined at right angles, houses one or more optical interferometers. The interferometers are used to measure minute changes in the apparent distances between test masses at the ends of the arms caused by a passing gravitational wave. The predicted distortion in space caused by a gravitational wave from a likely type of source is of order one part in 10^{21}, meaning that the expected change in the apparent 4-km length is only of order 4×10^{-18} m or about $1/1000^{th}$ of the size of a proton. The 4-km length for LIGO, by far the largest for any optical interferometer, was chosen to make the expected signal as large as possible

within the terrestrial constraints. Looking for coincident signals in all the interferometers simultaneously increases the likelihood for gravitational wave detection.

Principal Scientific Goals: Of the four known fundamental forces of nature (electromagnetic, weak, strong, and gravitational), the gravitational force is the most enigmatic. It is by far the weakest, yet it holds the universe together, ignites the fusion reaction in stars, and curves space in black holes so severely that light is trapped. And, although the universe is believed to be filled with gravitational waves from a host of cataclysmic cosmic phenomena, we have never detected a gravitational wave and measured its waveform.

The principal scientific goals of LIGO are to detect gravitational waves on Earth for the first time and to develop this capability into a new window on the universe, a window through which we can observe phenomena such as the inspiral and coalescence of neutron stars in binary orbit, black hole collisions, unstable dynamics of newborn neutron stars, supernovae, stochastic background from the early universe, and a host of more exotic or unanticipated processes.

Principal Education Goals: LIGO is a significant source of highly trained Ph.D. graduates for the country's workforce. In addition LIGO has a diverse set of educational activities at its different sites, activities that involve a large number of undergraduate (including those from minority serving institutions), hands-on activities for K-12 classes, teachers at all levels, and informal education and outreach activities for the public, including a planned Visitor's Center at the Livingston, LA site.

Connections to Industry: Substantial connections with industry have been required for the state-of-the-art construction and measurements involved in the LIGO projects. Some have led to new products. Areas of involvement include novel vacuum tube fabrication technology, seismic isolation techniques, ultrastable laser development (new product introduced), development of new ultra-fine optics polishing techniques, and optical inspection equipment (new product).

Management and Oversight: LIGO is sponsored by NSF and managed by Caltech under a cooperative agreement. The management plan specifies significant involvement by the user community, represented by the LIGO Scientific Collaboration (LSC), and collaboration with the other major gravitational wave detector activities in Japan, Europe, and Australia. External peer-review committees organized by the NSF help provide oversight through an annual review. NSF oversight is coordinated internally by the LIGO program director in the Division of Physics (MPS), who has also convened a LIGO Project Advisory Team, comprising staff from the Office of General Counsel, the Office of Legislative and Public Affairs, and Budget, Finance and Award Management. The Project Advisory Team has been in existence since 1994.

Current Project Status: All three LIGO interferometers were fully operational by the spring of 2002. Since then, activity has been divided between improving the sensitivity of the interferometers and collecting scientific data. The first science run, S-1, accumulated nearly 100 hours of triple coincidence data in the period from August 23, 2002 to September 9, 2002 with a sensitivity of about a factor of 100 from the design goal. Results from S-1 have been announced at major scientific conferences and submitted to peer review journals. Work on instrumental refinements between the end of S-1 and the beginning of S-2 in February 2003 produced sensitivities about ten times better than those observed in S-1, i.e., only a factor of about 10 from the design goal. S-2 lasted 59 days (February 14, 2003 – April 14, 2003) with over 300 hours in triple coincidence accumulated. In S-3 (October 31, 2003 – January 8, 2004), the sensitivity achieved with the best of the three interferometers was only about a factor of 3.5 from the design goal, strengthening expectations that the sensitivity for S-4 that should commence sometime in the second half of 2004 will be at or very near the targeted level. The FY 2005 Request for LIGO totals $33.0 million, the same as the FY 2004 Estimate. This funding level reflects work to

develop improved interferometers and full operations of the Laser Interferometer Gravitational-wave Observatory (LIGO) to run their interferometers at sites at Hanford, WA and Livingston, LA in coincidence with each other and with gravitational wave detectors abroad.

Funding Profile: The history of the LIGO project dates back to early conceptual work in the mid-1970s, moving through pre-construction R&D in the late 1980s to the initiation of LIGO construction in FY 1992. LIGO pre-dates the establishment of the MREFC Account in FY 1995.

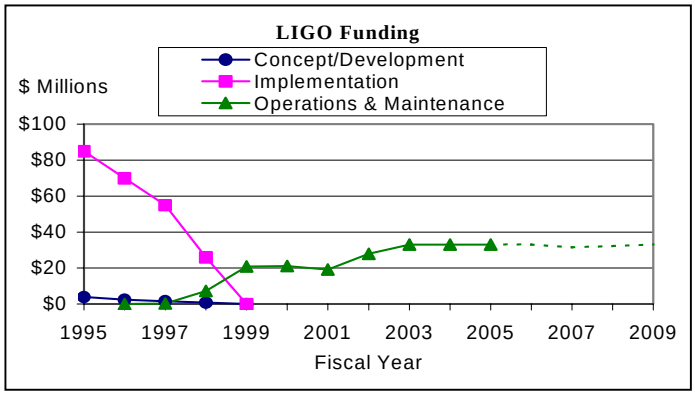
LIGO Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		Grand
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	Total
FY 1994 & Earlier	$38.70		$35.90				$74.60		$74.60
FY 1995	4.00			$85.00			4.00	$85.00	89.00
FY 1996	2.38			70.00			2.38	70.00	72.38
FY 1997	1.62			55.00	$0.30		1.92	55.00	56.92
FY 1998	0.86			26.00	7.30		8.16	26.00	34.16
FY 1999					20.80		20.80		20.80
FY 2000					21.10		21.10		21.10
FY 2001					19.10		19.10		19.10
FY 2002					28.00		28.00		28.00
FY 2003					33.00		33.00		33.00
FY 2004 Estimate					33.00		33.00		33.00
FY 2005 Request					33.00		33.00		33.00
FY 2006 Estimate					33.00		33.00		33.00
FY 2007 Estimate					33.00		33.00		33.00
FY 2008 Estimate					33.00		33.00		33.00
FY 2009 Estimate					33.00		33.00		33.00
Subtotal, R&RA	$47.56		$35.90		$327.60		$411.06		
Subtotal, MREFC				$236.00				$236.00	
Total, each phase		$47.56		$271.90		$327.60			$647.06

NOTE: The present table differs from the previous FY 2004 Budget Request to Congress in the amounts recorded for Operations and Maintenance. In the present Request, amounts recorded in Operations and Maintenance for FY 2002 – FY 2006 reflect the total amount of the award and now include research and development for improved gravitational wave detectors, previously reported under Disciplinary Research. The expected operational lifespan of this project is about 20 years. Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Concept/Development: Funds supported three phases of planning, design and development for LIGO: early conceptual R&D - $11.60 million (FY 1975-87); pre-construction R&D - $16.0 million (FY 1988-91); and ongoing R&D throughout construction - $20.0 million (FY 1992-98).



- Implementation: LIGO construction occurred between FY 1992-98, totaling $271.90 million. Prior to the start of the MREFC Account, construction funding was provided through the R&RA Account.

- Management and Operations: LIGO commissioning and operations costs began phasing-in in FY 1997. Commissioning costs are included in LIGO operations (as reported in NSF budget justifications to Congress) through FY 2001. Operations with the first science run began in FY 2002.

Renewal or Termination: The cooperative agreement for the support of LIGO operations is in its third year and expires in FY 2006. NSF expects to renew the agreement at that time pending a satisfactory review of the anticipated proposal from the LIGO Laboratory for a renewal.

Associated Research and Education Activities: Active Outreach programs have been developed at both the Livingston and Hanford sites. Teams at both sites have provided visual displays, hands-on science exhibits, and fun activities for visiting students and members of the public. In the last three years an average of over 2000 students per year have taken advantage of this opportunity. More formal programs at the sites include participation in the Research Experience for Teachers (RET) Program, a set of "scientist-teacher-student" research projects in support of LIGO, and participation in the Research Experiences for Undergraduates (REU) programs for college students. In collaboration with RET participants and networks of local educators, both sites have developed Web-based Resources for teachers that includes information on research opportunities for schools and a set of standards-based classroom activities, lessons, and projects related to LIGO science. Plans are in progress to hire an outreach coordinator at each site to augment the existing activities.

Science Support: Along with direct operations and maintenance support for LIGO, NSF supports science and engineering research directly related to LIGO activities through ongoing research and education programs. The annual support for such activities is estimated to be about $5.0 million.

In 1997, LIGO founded the LIGO Scientific Collaboration (LSC) to organize the major international groups doing research that was supportive of LIGO. The LSC now has 44 collaborating institutions with over 440 participating scientists. The role and membership responsibilities of each participating institution are determined by a MOU between the LIGO Laboratory and the institution. The LSC plays a major role in many aspects of the LIGO effort including: R&D for detector improvements, R&D for Advanced LIGO, data analysis and validation of scientific results, and setting priorities for instrumental improvements at the LIGO facilities.

National High Magnetic Field Laboratory (NHMFL)

Project Description: The NHMFL develops and operates high magnetic field facilities that scientists use for research in physics, biology, bioengineering, chemistry, geochemistry, biochemistry, materials science, medicine, and engineering. It is the world's largest and highest-powered magnet laboratory, outfitted with a comprehensive assortment of high-performing magnet systems. Many of the unique facilities were designed, developed, and built by the magnet engineering and design team at the NHMFL in collaboration with industry. The facilities are available to all qualified scientists and engineers through a peer-reviewed proposal process.

Principal Scientific Goals: NHMFL scientific goals are to provide the highest magnetic fields, state-of-the-art instrumentation, and support services for scientific research conducted by users from a wide range of disciplines, including all areas of science and engineering.

Principal Education Goals: NHMFL promotes science education and assists in developing the next generation of scientists, engineers, and science education leaders. A variety of programs, opportunities, and mentorship experiences are available for teachers and students at all academic levels-K-12 through post-graduate. The laboratory, with its distinguished faculty and world-class facilities, provides a unique interdisciplinary learning environment and has had a national impact in curriculum development. In FY 2003, its regional K-12 outreach efforts engaged over 6800 students from Florida and neighboring Georgia hands-on science activities and tours of the laboratory.

Partnerships and Connections to Industry**:** The Magnet Science and Technology (MS&T) Division of the NHMFL has broad responsibility to develop high magnetic fields and materials for high field magnet wires in response to national needs, such as building advanced magnet systems for the NHMFL sites, working with industry to develop the technology to improve and address new opportunities in magnet-related technologies, and pushing the state-of-the-art beyond what is currently available in high field magnet systems through materials research and magnet technology development. To this purpose, MS&T has established leading capabilities in many aspects of magnet system engineering and assessment. In addition, MS&T cooperates with industry and other international magnet laboratories on a variety of technology projects, including the advancement of conducting materials for magnets, including high quality Cu-Nb micro-composite wires with outstanding characteristics (strength, conductivity, and resistive ratio) now available for the construction of high field coils. These projects cover the range of analysis, design, materials, component development and testing, coil fabrication, cryogenics, system integration and testing.

The laboratory engages in numerous consortium as one of its mission objectives "to engage in the development of future magnet technology." NHMFL researchers and staff work with both academic and non-academic private partners in diverse areas of magnet technology. In 2003, the laboratory collaborated with 17 private sector companies, 13 national laboratories and federal centers, and 19 international institutions. In addition, the NHMFL has established numerous partnerships and programs to enhance science education and public awareness. The annual open house, with many hands-on demonstrations, attracts over 3,000 people.

Management and Oversight: The NHMFL is operated for the NSF by a collaboration of institutions comprising Florida State University (FSU), the University of Florida (UF), and Los Alamos National Laboratory (LANL) under a cooperative agreement that sets forth the goals and objectives of the NHMFL. NSF established the NHMFL in 1990 and new facilities were dedicated and open to users in October 1994. FSU, as the signatory of the cooperative agreement, has the responsibility for establishing and maintaining appropriate administrative and financial oversight and for ensuring that the operations of the laboratory are of high quality and consistent with the broad objectives of the cooperative agreement.

The principal investigator serves as the director of the NHMFL. Four senior faculty members serve as co-principal investigators. The laboratory is organized into three functional activities: User Programs, Magnet Science and Technology Programs, and Research Programs. In addition, the NHMFL has an Office of Government and Public Relations that oversees corporate outreach activities, including interactions with private industry, federal agencies and institutions, and international organizations. The NHMFL also operates a Center for Integrating Research and Learning (CIRL) that manages educational outreach at all levels. Through the organizational network, the director receives guidance and recommendations from the NHMFL Executive Committee, staff, the participating institutions, and user communities. Two external committees meet regularly to provide the laboratory with critical advice on important user, management, and operational issues. The Users' Committee, elected by the user community, reflects the broad range of users of all of the NHMFL facilities and provides guidance on the development and use of NHMFL facilities and services in support of users. The External Advisory Committee comprises representatives from academic, government, and industrial organizations, and from

the user community and reports directly to the President of Florida State University. It provides advice and guidance on matters critical to the success of the management of the NHMFL.

From the inception of the NHMFL, NSF administration and oversight was the responsibility of the Executive Officer, Division of Materials Research (MPS), with guidance from an *ad hoc* working group with representatives from the Division of Chemistry (MPS), the Directorate for Engineering, and the Directorate for Biological Sciences. Site visit reviews are conducted annually. Representatives from other federal agencies including DOE and NIH are invited to participate as observers at the site visit reviews. In July 2002 a new position of Program Director, National Facilities, was established in the NSF Division of Materials Research (DMR). Primary responsibility for NSF administration and oversight of the NHMFL was then assigned to this position, together with similar responsibilities for DMR's other national facilities.

Current Project Status: The NHMFL was established in FY 1990. It is currently moving its primary emphasis from magnet technology and development to a new phase of service to users and research. A 5-year renewal proposal was reviewed in FY 2000. More than 300 groups currently use the NHMFL facilities annually, and the laboratory was described by the NSF external review committee as the leading institution of its kind in the world. The National Science Board approved NSF support for the requested 5-year period (January 2001 through December 2005), making support for the final three years of the award contingent on satisfactory progress in the R&D program, management, and leadership of the Nuclear Magnetic Resonance program. A comprehensive NSF site visit review was conducted in May 2002; progress was assessed as satisfactory and the NSB was informed of the outcome of this review in October 2002. A subsequent annual review was conducted in October 2003. The site review committee concluded that the NHMFL is handling its overall mission very well. In particular, the changes made in proposing and tracking large, new magnet projects are important and should be continued. The NHMFL should also continue the process of commissioning the 900 MHz NMR magnet. The NHMFL should continue its efforts to strengthen the NMR program.

The FY 2005 Request for the NHMFL totals $25.61 million, an increase of $1.0 million over FY 2004 Estimate of $24.61 million. This increase reflects the second year of phasing in support for the National High Field Mass Spectrometry Facility (NHFMS). NHFMS was supported by the Chemistry Subactivity of MPS as a separate facility until FY 2003. The National High Field Mass Spectrometry (NHFMS) facility is located at the National High Magnetic Field Laboratory (NHMFL) in Tallahassee, Florida. Its purpose is to develop and exploit the unique capabilities of Fourier Transform Ion Cyclotron Resonance (FT-ICR) mass spectrometry. To that end, the NHFMS facility is routinely used to analyze samples that require ultrahigh resolution and high mass accuracy of FT-ICR. Examples of the ultrahigh resolution provided by this technique include the precise identification of thousands of molecular components in complex biological, pharmaceutical, or petroleum samples. In FY 2004, this facility will be integrated into the NHMFL and supported at $500,000. Future funding will be provided through the NHMFL.

Funding Profile: All NSF funding for the NHMFL to date has been provided through the R&RA Account.

NHMFL Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994 & Earlier	$28.00	$20.00	$48.00
FY 1995	6.30	5.70	12.00
FY 1996	6.00	11.50	17.50
FY 1997	6.80	10.70	17.50
FY 1998	5.30	12.20	17.50
FY 1999	5.50	12.00	17.50
FY 2000	5.20	12.30	17.50
FY 2001	6.20	13.80	20.00
FY 2002	7.97	17.00	24.97
FY 2003[1]	6.50	17.61	24.11
FY 2004 Estimate[2]	3.44	21.17	24.61
FY 2005 Request[2]	3.83	21.78	25.61
FY 2006 Estimate[2]	4.00	21.65	25.65
FY 2007 Estimate[2]	4.00	21.65	25.65
FY 2008 Estimate[2]	4.00	22.00	26.00
FY 2009 Estimate[2]	4.00	22.00	26.00

[1]Includes $183,272 in funding for the Research Experiences for Teachers Program.

[2]Includes funding for the National High Field Mass Spectrometry Center (not included in FY 2003 at $0.99 million).

Note: The data is presented as being either Implementation (permanent equipment) or Operations and Maintenance (non-permanent equipment). Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Implementation: The NHMFL supports a wide range of state-of-the-art magnets and instrumentation that are continuously upgraded for the user community. Capacitor driven magnets are the backbone of user programs at the Pulsed Field Facility at Los Alamos. A new 15 mm bore gap-cooled design has been tested and upgrades are underway from the current level of 60 to 65 tesla. The 60 tesla Long Pulse Mark II magnet and the 100 Tesla Multi-shot Magnet are currently under construction. Recently, an ultra fast coherent THz spectroscopy for measurement of high frequency complex conductivity in the range between 100 GHz to 2000 GHz has been developed for the Pulsed Field Facility. The Florida-Bitter DC magnets form the core of the user facilities in Tallahassee, which range from 20 to 45 telsa. Significant upgrades of existing magnets are in progress. The 33 tesla-class magnets will be upgraded to 35 tesla with a 32 mm bore. A new magnet will provide 32 tesla with a 50 mm bore, which is an increase of 7 tesla over the current magnet. The NHMFL hybrid magnet operates routinely at 45 tesla and the rebuild of one of the superconducting coils may allow the hybrid to reach 47 tesla. The 900 MHz wide bore and high-resolution NMR magnet system is in its final stages of testing and depending on the number of training quenches, the first spectra should be obtained in Spring/Summer 2004. In addition, the high temperature superconducting magnet and materials group, in collaboration with Oxford

Superconducting Technologies, designed and built a high field 5 tesla insert coil and successfully tested it in the 20 tesla wide bore resistive magnet. World records for high field insert coils were established for current density in the high temperature superconducting (HTS) winding at high field, stored energy, peak mechanical stress, diameter in a layer-wound HTS coil, and the total number of turns.

- Operations and Maintenance: These funds support the operation of the NHMFL, including magnet technology and development, support for user programs, in-house research, routine maintenance, instrumentation and technical services, and education and outreach programs. The increased level of maintenance and operations support that began in FY 2002 enabled the NHMFL to strengthen its programs for user support, equipment and facility maintenance, educational outreach and partnerships, and in-house research, and to meet increased costs for internal facilities and administration including electricity demand charges to operate high-field magnets. Research in the DC general-purpose facility is supported by eight scientists and an engineer whose specialties cover the kinds of measurements needed for most of the science done at the NHMFL work directly with users. In addition, the DC facility is supported by eight magnet plant and cryogenic system operators and mechanical, electronic, and computer engineers and technicians.

Renewal or Termination: The cooperative agreement for the support of NHMFL operations will expire in FY 2005. NSF plans are to consider support of the NHMFL either by renewal or recompetition.

Associated Research and Education Activities: The NHMFL base award currently includes approximately $240,000 per year in support of Research Experiences for Undergraduates and a wide variety of pre-college educational outreach and partnership activities with additional funding from the State of Florida. Supplementary NSF funding of $183,272 supports a Research Experiences for Teachers program for FY 2003 and FY 2004.

Participation in NHMFL Education Programs

Year	K-12	Undergrad[1]	Graduate[2]	Teachers[3]
FY 1994	1,200	8	N/A	3
FY 1995	1,515	10	N/A	9
FY 1996	3,990	16	N/A	30
FY 1997	4,075	18	19	255
FY 1998	4,080	18	15	547
FY 1999	7,100[a]	20	16	385
FY 2000	4,266	21	22	1,875 [b]
FY 2001	3,959	17	20	1,117
FY 2002	3,500	15	22	1,319
FY 2003 Est	6,841	21	N/A[c]	226[d]

[1]Undergraduates participating in the Summer Minority Program and/or REU

[2]NHMFL-affiliated graduate students earning Ph.D.'s

[3]Reflects teachers participating in workshops, Ambassador Program, and Research Experiences for Teachers

[a]Statewide implementation of curriculum project in 1999

[b]Teacher workshops extended to Connecticut and Illinois in 2000

[C]2003 data available in February 2004.

[d] State of Florida eliminated funding for "Science, Tobacco and You" Program

In addition to the individuals depicted in the table above, the NHMFL also integrates undergraduate and graduate students and postdoctoral fellows into its ongoing research activities on a regular basis. For example, during 2003, the NHMFL at FSU supported an average of 86 graduate students, 29 postdocs, and 16 undergraduates through awards outside the NSF-NHMFL core funding, e.g., individual investigator grants, state funding, and external sources. The NHMFL is actively preparing and recruiting the next generation of high-field magnet scientists, engineers, and users.

Science Support: Users are supported by NSF, other Federal, state and local agencies, other national agencies, and the private sector. User projects and time are allocated by merit on a competitive basis. NSF does not track the level of user support from non-NSF sources. The laboratory serves more than 2,000 individuals annually.

National Nanotechnology Infrastructure Network (NNIN)

Project Description: The National Nanotechnology Infrastructure Network (NNIN) comprises 13 university sites that will form an integrated national network of user facilities supporting research and education in nanoscale science, engineering, and technology. The NNIN will provide users across the nation with access, both on-site and remotely, to leading-edge tools, instrumentation, and capabilities for fabrication, synthesis, characterization, design, simulation, and integration. The broad scope of NNIN coverage includes areas of physics, chemistry, materials, mechanical systems, geosciences, biology, life sciences, electronics, optics, molecular synthesis, and molecular scale devices, among others. The NNIN expands significantly beyond the capabilities of the five-university National Nanofabrication Users Network (NNUN), which concluded after ten years of NSF support at the end of 2003.

Principal Scientific Goals: The NNIN's broad-based national user facilities will enable the nation's researchers from academia, small and large industry, and government to pursue new discoveries and applications in diverse domains of nanoscale science and engineering, and will help stimulate technological innovation. The network will also develop the infrastructure and intellectual and institutional capacity needed to examine and address societal and ethical implications of nanotechnology.

Principal Educational and Outreach Goals: The NNIN will undertake on a national scale a broad spectrum of innovative activities in education, human resource development, knowledge transfer, and outreach, with special emphasis on non-traditional users and under-represented groups, including women and minorities.

Partnerships and Connections to Industry: The NNIN will leverage its capabilities through connections and extensive collaborations with national and industrial laboratories, and with foreign institutions. Through these partnerships and joint meetings and workshops, the network will share expertise and perspectives, provide specialized training opportunities, coordinate access to unique instrumentation, and transfer newly developed technologies.

Management and Oversight: The NNIN will be managed as a cohesive and flexible network partnership through a Network Executive Committee derived from the individual Site Directors, and the Education/Outreach and Society/Ethics Coordinators. The Network Director will provide intellectual leadership for the network; be responsible, in cooperation with the Network Executive Committee, for developing strategies, operational plans, and coordination of the activities of the network; and serve as the principal contact on behalf of the network with the NSF. An external Network Advisory Board will meet at least annually and will provide independent advice and guidance to the Network Director and Executive Committee concerning the network's programs, activities, vision, funding allocations, and new directions. The Advisory Board will share its major recommendations with the NSF. The Site Directors

will be responsible for local management functions of the individual user facilities, for interfacing with other facilities and with the management team for the overall network, and for connections with the outside communities.

NSF will provide oversight to the NNIN under a cooperative agreement. The NNIN will be reviewed through annual site reviews. In addition, a semi-annual review will be held at the NSF attended by the Network Director and Executive Committee members. The program officer for the NNIN activity will reside in the Engineering Directorate, Division of Electrical and Communications Systems. The program officer will coordinate NNIN oversight with other Division and Directorate members of the NNIN working group.

Current Project Status: The NNIN was approved by the National Science Board in November 2003. An award under a cooperative agreement is anticipated for February 2004. NSF requests $13.86 million in FY 2005, an increase of $1.41 million over the FY 2004 Estimate of $12.45 million.

NNIN Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 2004 Estimate		$12.45	$12.45
FY 2005 Request		13.86	13.86
FY 2006 Estimate		18.52	18.52
FY 2007 Estimate		21.29	21.29
FY 2008 Estimate		25.09	25.09
FY 2009 Estimate		28.85	28.85
Total	$0.00	$120.06	$120.06

FY 2003 was the final year of funding for NNIN's predecessor program, the National Nanofabrication Users Network (NNUN) at $6.05 million.

Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Implementation: N/A

- Management and Operations: The major portion of NSF funds provide for operation and staffing of the user facilities and associated network activities. They also provide for acquisition and for in-house development of appropriate instrumentation, tools, and processes to serve the user needs. The predecessor NNUN supported the national infrastructure through advanced micro- and nanofabrication facilities, instrumentation, processes, and expertise. In the NNUN's most recent reporting year of 2003, nearly 2,000 unique users, including 1300 graduate and undergraduate students, from 33 states, 8 foreign countries, and 158 start-up and small companies benefited from use of its facilities. For the NNIN, beginning in FY 2005, there is a provision of up to a 15 percent annual increase in its budget to cover expected growth in the user base, with related increased education, training and staffing costs; and enhanced instrumentation.

Renewal or Termination: The award may be renewed once, without re-competition, for an additional five years, subject to satisfactory review of performance and availability of funds. The maximum duration of the award is for ten years.

Associated Research and Education Activities: The institutions comprising the NNIN have strong underlying internal research programs that provide critical research mass and knowledge base in developing new processes, methodologies, and instrumentation. The NNIN educational contributions will include a hyperlinked open textbook on nanotechnology for undergraduate and graduate students, a science magazine designed to stimulate and challenge 6-10 years olds to explore the physical sciences, a web-based multimedia suite encompassing training and courses for various disciplines in nanoscale science and engineering, and a network-wide research experience for undergraduates program.

Science Support: NSF and other agencies independently award research grants to principal investigators who may use the NNIN facilities to carry out some aspects of their research projects.

National Superconducting Cyclotron Laboratory (NSCL)

Project Description: This project supports the operation of the NSCL at Michigan State University (MSU) as a national user facility and also supports the MSU research program. The NSCL is the leading rare isotope research facility in the United States. NSCL scientists and researchers employ a wide range of tools for conducting advanced research in fundamental nuclear science, nuclear astrophysics, and accelerator physics. Important applications of the research conducted at the NSCL benefit society in numerous areas, including new tools for radiation treatments of cancer patients and the assessment of health risks to astronauts. The NSCL began operations of the coupled cyclotron radioactive beam facility in FY 2002, providing users with unique access to beams of unstable nuclei. The NSCL is among the world leaders in heavy ion nuclear physics and, now nuclear physics with radioactive beams.

The NSCL operates two superconducting cyclotrons. The K500 was the first cyclotron to use superconducting magnets, and the K1200 is the highest-energy continuous beam accelerator in the world. These and other related devices have enabled researchers to learn more about the origins of the elements in the cosmos. Through the newly completed Coupled Cyclotron Facility (CCF), heavy ions are accelerated by the K500 and then injected into the K1200, enabling the production of rare unstable isotopes at much higher intensities.

Principal Scientific Goals: Scientists at the NSCL work at the forefront of rare isotope research. They make and study atomic nuclei that cannot be found on earth and perform experimental research using beams of unstable isotopes to extend our knowledge of new types of nuclei, many of which are important to an understanding of stellar processes. Research activities include a broad program in nuclear astrophysics studies, the studies of nuclei far from stability using radioactive ion beams, and studies of the nuclear equation of state. In addition, research is carried out in accelerator physics.

Principal Education Goals: NSCL supports and enhances Ph.D. level graduate education and post-doctoral research experience. In addition, the site provides research experiences for undergraduate students, as well as training for K-12 teachers.

Partnerships and Connections to Industry: NSCL occasionally enters into license agreements with industry for cyclotron technology or nuclear electronics. A specific license agreement with Accel Corporation exists for compact cyclotrons based on superconducting technology.

Management and Oversight: The NSCL is managed by the Laboratory Director and two Associate Directors; one for Nuclear Science and one for Accelerator Research. During the NSCL upgrade, NSF convened several technical panels to review cost, schedule, technical progress, and management of the project. The NSCL research program is guided by a Program Advisory Committee consisting of external experts as well as an in-house expert, and includes the chairperson of the full NSCL User Group. The procedure for users includes writing and submitting proposals to the NSCL Director and oral presentations. There are two opportunities for proposal submission each year. Approximately 5,000 beam hours for experiments are provided each year. There is generally at least a one-year backlog for experiments. NSF oversight is provided through annual site visits by the cognizant program officer of the Physics Subactivity (MPS) and other staff, accompanied by external experts.

Current Project Status: An experimental program using the recently completed coupled cyclotron facility is now underway. The FY 2005 Request for the NSCL totals $16.65 million, an increase of $1.0 million over FY 2004 Estimate of $15.65 million. This increase will support operations and research at this unique radioactive ion beam facility.

Funding Profile: All funding for NSCL to date has been provided through the R&RA Account.

NSCL Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994		$9.40	$9.40
FY 1995		9.40	9.40
FY 1996		9.70	9.70
FY 1997	$2.10	9.20	11.30
FY 1998	1.90	9.80	11.70
FY 1999	6.00	9.80	15.80
FY 2000	4.70	9.90	14.60
FY 2001	1.00	11.40	12.40
FY 2002	0.40	14.41	14.81
FY 2003		15.65	15.65
FY 2004 Estimate		15.65	15.65
FY 2005 Request		16.65	16.65
FY 2006 Estimate		17.40	17.40
FY 2007 Estimate		17.40	17.40
FY 2008 Estimate		17.40	17.40
FY 2009 Estimate		17.40	17.40

NOTE: Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available. A new cooperative agreement will be competed in FY 2007.

Information pertaining to the data in the table is included below.

- Implementation*:* The facility was recently upgraded to couple two superconducting cyclotrons and to upgrade the fragment separator to produce intense beams of unstable isotopes providing a

facility unique in the world. This recent upgrade of the NSCL to the coupled cyclotron facility was accomplished using $12.0 million in incremental funding from the NSF and over $6.0 million from MSU. In addition, $4.0 million was provided to upgrade the cryogenic plant.

- Operations and Maintenance: Funding within this category supports the operation of the facility. Such activities include routine preventative maintenance of the two coupled NSCL cyclotrons, including vacuum systems, RF power systems, beam transport systems, the helium refrigerator used to supply coolant for the superconducting cyclotrons, and miscellaneous subsystems, are carried out each quarter. Approximately 25 percent of the funding is directed toward in-house research (both experimental nuclear science and accelerator research and development) with the remainder used to operate and maintain the facility for all users. The facility serves several hundred users.

Renewal or Termination: The current cooperative agreement expires in FY 2006. NSF expects to consider a proposal to renew the program, and funding amounts for FY 2007 and beyond will be determined through negotiation at that time.

Associated Research and Education Activities: The figures shown in the table, below, under K-12 and Teachers are participants in the NSCL Physics of Atomic Nuclei (PAN) program. This is a two-week summer program sponsored by MSU with the objective to stimulate an interest in science; particularly in female and minority students. The figures shown in the Undergraduates column are the approximate number employed by the NSCL to assist researchers or to work with staff members in operating and maintaining the facility. Figures shown under Graduate are the number of students completing their Ph.D. at MSU in each fiscal year. Additional students from other institutions participated in experiments conducted at the NSCL, but figures are not shown.

Participants in the NSCL Physics of Atomic Nuclei (PAN) Program

Year	K-12	Undergrad	Graduate	Teachers
FY 1998	25	65	4	9
FY 1999	25	65	4	13
FY 2000	21	65	2	12
FY 2001	20	55	5	13
FY 2002	21	58	6	12
FY 2003 Est.	21	58	6	12

Science Support: Theoretical nuclear physics research at the NSCL is separately supported by annual grants totaling approximately $500,000. Additionally, in several recent years Major Research Instrumentation (MRI) grants have been awarded, which have permitted construction of detectors and other equipment important to the operation of the laboratory as a user facility.

Ocean Drilling Program/Integrated Ocean Drilling Program

Project Description: The Ocean Drilling Program (ODP) terminated active operations in September 2003 with its final drilling programs in the North Atlantic. During 18 years of ODP operations, NSF provided 60 percent of the program's resources and all of the required facilities, with the remaining funding provided by international partners. Phase-out of program and contract activities is planned through FY 2007.

The Integrated Ocean Drilling Program (IODP) beginning in FY 2004, is the successor program to the Ocean Drilling Program (ODP), and represents an expanded international partnership of scientists, research institutions, and funding agencies organized to explore the evolution and structure of Earth as recorded in the ocean basins. Ocean drilling is an essential capability in modern geoscience research and education and is used to examine processes ranging from changes in the Earth's climate to the rifting and drifting of continents. Over 600 ocean and earth scientists have completed an internationally coordinated planning effort to examine the scientific objectives for IODP, culminating in the Initial Science Plan, *Earth, Oceans, and Life*. These objectives require a heavy vessel for drilling deep sedimentary and crustal holes, a lighter vessel to provide widely distributed arrays of high-resolution cores to address climate, environmental, and observatory objectives, and occasional use of drilling platforms for the Arctic and nearshore projects, which cannot be undertaken from the two primary IODP vessels.

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan has secured funding of approximately $500.0 million and has completed construction of the heavy drillship *Chikyu* (Earth, in Japanese) to address deep drilling objectives in the new program. *Chikyu* was launched in January 2002, will undergo testing in 2004-2006, and will be available for IODP operations in 2007. NSF's planned contribution to this program includes the acquisition, conversion and outfitting of a vessel suitable to achieve the goals of the light vessel requirement using MREFC funds in FY 2005 and FY 2006. An initial period of light drillship operations, beginning in June 2004 and expected to last for one year, will occur on the *JOIDES Resolution.* The European Consortium for Ocean Research Drilling (ECORD) has been organized by 12 European countries (4 additional country memberships are pending, one of which is Canada) for IODP participation and to provide short-term use of chartered drilling platforms for near-shore and Arctic objectives. Arctic operations are expected to commence in August 2004.

After operations begin, IODP will provide sediment and rock samples (cores), shipboard and shore-based facilities for the study of these samples, downhole geophysical and geochemical measurements (logging), and opportunities for special experiments to determine *in situ* conditions beneath the seafloor. The IODP drilling platforms will collect geologic samples from the floor of the deep ocean basins primarily through rotary coring and hydraulic piston coring. The logs and samples of the cores will be made available to qualified scientists throughout the world for research projects.

Principal Scientific Goals**:** The IODP scientific program is identified in the Initial Science Plan for the IODP, Earth, Oceans and Life (http://www.iodp.org/isp.html), and includes emphasis on the following research themes:

- The Deep Biosphere and the Sub-seafloor Ocean: Drilling will concentrate on defining the architecture and dynamics of the vast subseafloor plumbing system, where flowing water alters rock, modifies the long-term chemistry of the oceans, lubricates seismically active faults, concentrates economic mineral deposits, and controls the distribution of the deep biosphere.
- The Processes and Effects of Environmental Change: Using a global array of sites, ocean sediment cores will be used to construct a detailed record of the causes, rates and severity of changes in the earth's climate system and their relation to major pulses in biologic evolution.
- Solid Earth Cycles and Geodynamics: Drilling will concentrate on sampling and monitoring regions of the seafloor that currently have the highest rates of energy and mass transfer, and comparing these results to older geologic settings. A crucial initial program of deep drilling will be to study the seismogenic zone responsible for large destructive earthquakes along active plate boundaries.

Principal Education Goals: Undergraduate and graduate students participate in drilling expeditions, working with some of the world's leading scientists and becoming part of the intellectual fabric essential for future advances in the earth sciences. To reach students that do not participate directly in IODP,

investments are made in curriculum enrichment including interactive CD-ROMs, visiting lecture programs, museum displays, and remote classroom broadcasts from the drillship.

Connections to Industry: As it did in ODP, NSF plans to contract the services of the light drillship from a leading offshore drilling contractor. A commercial contractor will also provide downhole-logging services. In addition, scientists from industrial research laboratories will participate in IODP cruises, are members of the program's scientific and technical advisory committees, and have supplied data for planning and interpretation of drilling results.

Partnerships: MEXT and NSF will be equal partners in the IODP and will contribute equally to program operation costs. A consortium of 12 European countries and the People's Republic of China will officially join IODP in early 2004. In addition to its financial contribution, the European consortium will supply additional drilling facilities for IODP for short-term operations in shallow water and the Arctic.

Management and Oversight: NSF and MEXT have signed a Memoranda of Understanding with respect to cooperation in the IODP that identifies procedures for joint management of a contract to an IODP Central Management Office (CMO). The CMO will coordinate and support scientific planning, drilling platform activity, data and sample distribution, and publication and outreach activities through its management of commingled international science funds, collected and provided by NSF. A non-profit corporation founded by U.S. and Japanese institutions (IODP Management International, Inc.) has proposed to manage these scientific services for IODP. Drillship providers will be responsible for platform operational management and costs. NSF will provide the light drillship through contract with the U.S. System Integration Contractor (SIC), JOI Alliance, a consortium of the Joint Oceanographic Institutions, Inc. (JOI), Texas A&M University, and Lamont-Doherty Earth Observatory. MEXT will manage its drillship through the Japan Marine Science and Technology Center (JAMSTEC).

Scientific advice and guidance for IODP is provided through the scientific advisory structure (SAS). The SAS is responsible for providing scientific advice and guidance for IODP, and consists of the Science Planning and Policy Oversight Committee (SPOCC, the IODP executive authority) and an advisory structure headed by the Science Planning Committee (SPC). The CMO, under the direction of the SPC Chair, is responsible for the coordination of the SAS committees and panels, and for integrating the advice from the panel structure in a manner suitable for providing drilling and operational guidance to the CMO.

The Ocean Sciences Subactivity (GEO) manages the IODP for NSF under the NSF Ocean Drilling Program. NSF's Ocean Drilling Program is placed within the Marine Geosciences Section, with several program officers dedicated to its oversight. One of the program officers will serve as the contracting officer's technical representative on the CMO and SIC contracts.

Current Program Status and Future Program Planning: Drilling activity under the Ocean Drilling Program terminated in September 2003. The FY 2005 Request for ODP totals $4.0 million, an increase of $2.10 million over the FY 2004 Estimate of $1.90 million. Funds are being made available for core storage and data distribution. The increase in NSF funding in FY 2005 is due to late FY 2003 international contributions that were applied to FY 2004 costs, thus reducing NSF's contribution in FY 2004 to $1.90 million.

NSF and MEXT plan to contribute equally to IODP operations costs, with up to one-third of total costs contributed by the European consortium. NSF is requesting $32.10 million in FY 2005 for operations of the IODP program and for planning and design of the Scientific Ocean Drilling Vessel project through the R&RA Account. Further information on the future operations of IODP can be found under Scientific Ocean Drilling Vessel in the MREFC chapter.

Funding Profile**:** All funding for the operation of both the ODP and IODP has been provided through the R&RA Account.

Ocean Drilling / Integrated Ocean Drilling Funding Profile
(Dollars in Millions)

	Implementation	ODP Operations & Maintenance	IODP Operations and Maintenance	Total, NSF
FY 1994		$28.43		$28.43
FY 1995		27.55		27.55
FY 1996		27.68		27.68
FY 1997		27.09		27.09
FY 1998	$3.00	26.95		29.95
FY 1999	3.00	28.13		31.13
FY 2000		29.50	$0.10	29.60
FY 2001		30.60	0.20	30.80
FY 2002		31.50	0.30	31.80
FY 2003		30.00	0.00	30.00
FY 2004 Estimate		1.90	35.60	37.50
FY 2005 Request		4.00	31.60	35.60
FY 2006 Estimate		3.40	37.00	40.40
FY 2007 Estimate		3.10	65.00	68.10
FY 2008 Estimate		0.00	67.00	67.00
FY 2009 Estimate		0.00	69.00	69.00

NOTE: Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Not included in this table is the acquisition of the Scientific Ocean Drilling Vessel (SODV), to be proposed through the MREFC Account in FY 2005 and FY 2006. Please see the MREFC chapter for additional information pertaining to SODV.

Information pertaining to the data in the table is included below.

- Implementation: An upgrade was performed in September/October 1999, which required that the JOIDES Resolution be dry-docked for 58 days. NSF contributed $6.0 million and the ship's operator contributed $1.30 million for repairs and upgrades of the ship and its equipment necessary for the five-year contract extension through FY 2003.

- Operations and Maintenance: The general contractor for the overall management and operation of the ODP is Joint Oceanographic Institutions, Inc. (JOI), a consortium of major United States oceanographic institutions. Drilling operations and science support services (laboratory equipment, technical support, database maintenance, sample storage and distribution) are managed by Texas A&M University. Lamont-Doherty Earth Observatory of Columbia University manages logging. NSF provided support for participation and drilling-related research performed by U.S. scientists. In the IODP, operational management and science support services of the drill ships will be the responsibility of JAMSTEC for the *Chikyu*, and the JOI Alliance for the U.S. light drillship. The British Geological Survey (BGS) will provide similar support for occasional chartered drilling platforms. The CMO, under contract to NSF, will provide IODP scientific planning and coordination of drilling activities.

Renewal or Termination: At its inception, the Ocean Drilling Program was planned as a fixed duration program. The contract for the ship the program has utilized terminated at the end of FY 2003, and at that time, the drilling operations for Ocean Drilling Program ended. The Integrated Ocean Drilling Program is the next phase of scientific ocean drilling.

Associated Research and Education Activities: A breakdown of participants by year and by category is reflected in the table, below. Much of the support for Education and Outreach activities in ODP is through a cooperative agreement with JOI Inc., which has resulted in various educational products and services described here in brief. Two educational CD-ROMs with teaching activities have been developed and widely distributed. An educational poster titled, "Blast from the Past," describing the meteorite impact that led to the demise of the dinosaurs was printed, and 64,000 copies have been distributed. A brochure of abstracts (text and figures), highlighting 17 of the Ocean Drilling Program's greatest scientific accomplishments, was published and distributed. JOI also publishes a newsletter three times a year with a distribution of about 2,000. In addition, a display of ODP materials was produced and contributed to the Smithsonian Museum, in Washington DC, where it has been on permanent display since 1997. This display is viewed daily by thousands of museum visitors (numbers are not reflected in the table below).

The services of the program are also listed here in brief. A Distinguished Lecturer Series, through which each year, approximately 6 lecturers give a total of about 30 lectures at universities, colleges, and other institutions throughout the country. A new Undergraduate Student Trainee Program enables undergraduates to sail on a research vessel as members of the scientific team. Mentors and scientific projects are an integral part of this program. An internship program at JOI Inc. was initiated two years ago as an attempt to introduce recent graduates to the career opportunities of science program management. A longstanding fellowship program provides graduate student fellowship awards to conduct ODP research. Each year, JOI sponsors educational and promotional booths at national and international meetings where products and services are highlighted. The ODP drillship JOIDES Resolution has visited U.S. ports approximately 8 times since 1994. At each visit, ship tours are given, and promotional and educational activities have been held at four of these port calls. JOI/ODP sponsors scientific research and planning workshops that commonly involve graduate students. And lastly, many graduate students have sailed on the JOIDES Resolution.

In the IODP, program-wide Education and Outreach activities will be coordinated by the CMO, as will facilitation and support for national efforts in Education and Outreach. The JOI Alliance, JAMSTEC, and BGS, as operators of drilling platforms, will provide further support and materials for these efforts. The IODP U.S. Science Support Program (USSSP) will coordinate U.S. national efforts in Education and Outreach in a cooperative agreement with NSF. JOI has submitted a proposal, currently under review at NSF, to provide USSSP services.

ODP Participation

Year	K-12	Undergrad	Graduate	Teachers
FY 1994	620	1,500	1,300	700
FY 1995	620	1,550	1,400	700
FY 1996	620	1,500	1,400	700
FY 1997	2,620	6,210	4,900	1,800
FY 1998	1,300	4,110	3,800	1,300
FY 1999	2,600	5,740	5,900	2,200
FY 2000	17,600	13,680	7,400	4,200
FY 2001	5,600	9,750	9,400	9,700
FY 2002	6,000	8,000	9,500	7,000
FY 2003	6,500	8,500	9,500	7,500

Science Support: NSF provides most of the support for the participation of U.S. scientists in the ODP and will also do so in IODP. The majority of the funding comes from the Ocean Sciences Subactivity (GEO), with additional funding from the Office of Polar Programs related to Antarctic drilling research. Total funding for U.S. participation and analysis of samples and data is approximately $15.0 to $18.0 million annually.

Over 1,500 scientists from forty nations have participated on ODP cruises since 1985. About 700 of these have been U.S. scientists from 150 universities, government agencies, and industrial research laboratories who have participated in ODP cruises, with about 300 of them participating in more than one ODP cruise. Samples and data have been distributed to an additional 700 to 800 U.S. scientists. These 1,400 to 1,500 direct U.S. users of ODP materials constitute approximately 10 to 15 percent of the U.S. Geoscience community as identified by the American Geological Institute.

Partnerships for Advanced Computational Infrastructure / Widely-Shared Cyberinfrastructure

Project Description: FY 2005 marks the first year of NSF's plan to create a national cyberinfrastructure – an integrated system of state-of-the-art computing, communications and information resources, tools and services that will revolutionize the conduct of research and education across the science and engineering enterprise. Widely-shared cyberinfrastructure will provide broadly accessible and well-supported high-end computing, communications, storage, and analysis resources; it will include services to support the effective use of these resources by domain scientists and engineers; it will include education, outreach and training support to develop the workforce necessary to take full advantage of or to support this new infrastructure; and it will help create convergent technology and policy platforms that provide for interoperability across science and engineering fields and across organizational, regional and national boundaries. The Extensible Terascale Facility – also known as the Teragrid – will become operational in FY 2005 and serves as one essential component in the widely-shared cyberinfrastucture. Widely-shared cyberinfrastructure activities build on the successes of the Partnerships for Advanced Computational Infrastructure (PACI).

Principal Scientific Goals: Information technology has had widespread impact on science and engineering in the past decade – simulation and modeling are now as important to discovery as theory and experimentation, advances in sensor technology and the availability of affordable mass data storage devices are making possible the collection, creation and federation of large complex datasets, and pervasive networking technology is enriching collaborations and providing broad access to a multitude of scientific resources. Information technology also provides new opportunities to promote and advance learning where both formal and informal education activities are increasingly enabled by enhanced access

and peer-to-peer learning opportunities. However, this rapid growth in the use of information technology to advance science and engineering has come about in a largely uncoordinated manner, with limited pooling of resources or experiences, and with little thought given to the systems issues of design, interoperability and long-term sustainability. Beginning in FY 2005, NSF will capitalize upon the science and engineering opportunities provided by continuing advances in information technology through the creation and support of a widely-shared, integrated cyberinfrastructure that enriches and continues to revolutionize discovery, learning and innovation in all science and engineering domains. Widely-shared cyberinfrastructure supports and/or integrates a diverse set of advanced computing engines, data archives and digital libraries, observing and sensor systems, and other research and education instrumentation. It includes the development and deployment of production-quality, open-source and open-standards middleware – software that connects two or more applications across the Internet and allows those applications to share compute engines, data, networks and instruments.

Principal Education Goals: NSF seeks to ensure that the broadest range of individuals, institutions and stakeholder communities will participate in the design, development, deployment and/or use of widely-shared cyberinfrastructure. Consequently, in FY 2005 the agency will support new efforts that leverage the successes of the PACI-Education, Outreach and Training (EOT) activities, to prepare current and future scientists and engineers to use, develop and support cyberinfrastructure now and in the future.

Partnerships and Connections to Industry: Cyberinfrastructure is by definition a partnership activity and involves a large number of academic, industry and government partner organizations. There are also international partnerships. Examples of international partnerships include joint work with the Advanced Computational Modeling Centre at the University of Queensland in Australia, with the Parallel Computing Center at the Royal Institute of Technology in Stockholm, Sweden and with the Center for Research on Parallel Computation and Supercomputers in Naples, Italy.

NSF-supported organizations have had a number of industrial strategic partnerships with Fortune 500 Companies, including Allstate Insurance Company; the Boeing Company; Caterpillar Inc.; Eastman Kodak Company; J. P. Morgan; Kellogg Company; Motorola, Inc.; Sears; Shell Oil Company; Arena Pharmaceuticals; BAE Systems; Brocade; Ceres, Inc; Computer Science Corp.; Pfizer; JVC; Lockheed Martin; and ESRI. They also have had strategic technology partnerships with a number of companies including ANSYS, Inc.; Informix Corp.; Microsoft Corp.; SGI; Sun Microsystems; IBM; Qwest; Oracle; Compaq (now Hewlett Packard); Storage Tek; and Intel.

Management and Oversight: NSF awards for support of widely-shared cyberinfrastructure are made mainly through cooperative agreements. Each awardee is expected to manage their own operations and resources with oversight provided by an NSF (CISE-SCI) program officer. Investments in national supercomputing resources are being made through cooperative agreements with the National Center for Supercomputing Applications (NCSA), the San Diego Supercomputing Center (SDSC) and the partner institutions in the Extensible Terascale Facility. With upgrades in supercomputing capacity being completed during FY 2004, NSF will almost double the computing cycles being made available to the national science and engineering community. A National Resource Allocation Committee meets semi-annually to review and make recommendations on large supercomputing resource requests. Cooperative agreement awardees submit annual reports and plans that are often reviewed by committees of experts external to NSF. Committee recommendations are acted upon by the cognizant NSF program officer and reviewed by the Division Director. NSF investments are being informed by the recent report of the NSF Advisory Committee on Cyberinfrastructure, and by ongoing internal planning activities informed by discussions with the external science and engineering community.

Current Status: The FY 2005 Request for widely-shared cyberinfrastructure totals $137.90 million, an increase of $17.85 million over the FY 2004 Estimate of $120.06 million. This increase will support increased operations costs, and expansion of education outreach and training.

Funding Profile: All funds for the operations and maintenance of widely-shared cyberinfrastructure are being provided through the R&RA Account. In the past, NSF's main investments in widely-shared cyberinfrastructure were made through the Partnerships for Advanced Computational Infrastructure (PACI) as described below.

PACI Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994 & Earlier			$0.00
FY 1995			0.00
FY 1996			0.00
FY 1997			0.00
FY 1998	$21.30	$38.80	60.10
FY 1999	23.90	45.60	69.50
FY 2000	27.20	42.80	70.00
FY 2001	21.90	51.40	73.30
FY 2002	25.90	49.37	75.27
FY 2003	25.00	48.24	73.24
FY 2004 Estimate[1]	25.00	62.00	87.00

[1]FY 2004 total includes an additional $20.0 million in initial cyberinfrastructure investment through hardware upgrades.

Information pertaining to the data in the table is provided below.

- Concept/Development: Concept planning for PACI was done in the 1995-1997 time frame. The recent report of the NSF Advisory Committee for Cyberinfrastructure, issued in February 2003, is informing the agency's plans for widely-shared cyberinfrastructure.

- Implementation: Implementation of the PACI facilities included initial development of supercomputing facilities and includes upgrades to those facilities to maintain the highest performance computing possible. The Partnerships used approximately one third (actuals range from about 32 to 38 percent) of their annual budget for upgrades to keep their computational, storage and networking resources at a state-of-the-art level. In FY 2005, NSF remains focused on likely technology upgrades or new acquisitions in both hardware and software to ensure the national community has access to a state-of-the-art, enabling cyberinfrastructure.

- Operations and Maintenance: The Operations and Maintenance data provided below include funds that support the development of enabling and applications technologies. Approximately half of the funds listed are designated for this purpose. These funds, as defined in the PACI cooperative agreements, were to develop technologies that facilitate the efficient use of the computational resources provided by the program.

Cyberinfrastructure Funding Profile
(Dollars in Millions)

	Implementation[1]	Operations & Maintenance[2]	Total, NSF
FY 2005 Request	$40.00	$97.90	$137.90
FY 2006 Estimate	40.68	99.56	140.24
FY 2007 Estimate	41.49	101.55	143.04
FY 2008 Estimate	42.44	103.89	146.33
FY 2009 Estimate	43.50	106.49	149.99

Note: due to incorporation of other efforts, numbers are not comparable to PACI table. Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

[1]Implementation funds above represent support for networking costs, middleware and software development, education and training efforts, and other tools and services.

[2]Operations funding in FY 2005 and beyond represents operations and maintenance support for Widely-shared Cyberinfrastructure, of which support for the operation and maintenance of the Terascale Computing Systems is about $10.0 million in FY 2005. Terascale will be fully integrated with Cyberinfrastructure in future years. For further information on Terascale, please refer to the MREFC chapter.

Renewal or Termination: The PACI cooperative agreements will remain in effect through the end of FY 2004. In FY 2005, revised cooperative agreements with NCSA and SDSC will ensure the continuing provision of high-end computing resources and related services to the national community. Complementing the resources and services provided by NCSA and SDSC, in FY 2005 the Extensible Terascale Facility will begin to demonstrate the potential of revolutionary grid computing approaches to advance science and engineering research and education.

Associated Research and Education Activities: The table below indicates the impact that the PACI Program has had in the area of Education, Outreach and Training (EOT). Historically, the base funding for the EOT-PACI component amounted to approximately 5 percent of the funds for the two PACI cooperative agreements. Funds provided through the PACI Program were highly leveraged through donations from private foundations and through NSF funding from EHR and other programs within the NSF. PACI-EOT partners designed and administered numerous programs for underrepresented groups including Minority Serving Institutions, the Coalition to Diversity Computing, GirlTech, Teacher Education and Training Programs, etc. The numerous activities of the PACI-EOT team may be found at http://www.eot.org. NSF's new cyberinfrastructure activities aimed at education, outreach and training will expand upon the successes of PACI-EOT activities.

PACI Participation

Year	K-12	Undergrad	Graduate	Teachers
FY 1998	3,910	370	60	330
FY 1999	6,300	500	150	420
FY 2000	4,000	460	70	350
FY 2001	6,200	4,600	150	1,300
FY 2002	11,300	730	170	550
FY 2003	8,000	900	150	500

NOTE: FY 2001 Undergrads include 3,000 BioQuest-related undergrads. The large number in Teachers for that year is also related to BioQuest. In FY 2002, K-12 participants included a Girl Scout outreach program in the San Diego area.

Science Support: Leading-edge cyberinfrastructure resources serve many areas of scientific and engineering research supported by the NSF. Percent usage of computational resources by NSF Directorates for FY 2002 are shown in the following table:

Resource Usage, by NSF Directorate

NSF Activity	Percentage of Users	Percentage of Usage
BIO	9%	14%
CISE	20%	13%
ENG	16%	7%
GEO	9%	4%
MPS	41%	61%
SBE	4%	1%

It is estimated that the average annual support of the research and education groups using these facilities is in excess of $200.0 million. This is an estimate based on the number of users. There are approximately 600 projects, with an average of five to six users. We assume that approximately 200 large projects have an estimated grant support of $500,000 per year; approximately 400 smaller projects have estimated grant support of about $250,000 per year.

Other Facilities

Other Facilities support includes continued support for the Network for Computational Nanotechnology (NCN), which focuses on modeling and simulation of chemical, biological and pharmaceutical systems, and will include additional network nodes that focus on these areas. An increase of $1.50 million for a total of $3.85 million for NCN is requested. Other items within this category include facilities for computational sciences, physics, materials research, ocean sciences, atmospheric sciences, and earth sciences.

INFRASTRUCTURE AND INSTRUMENTATION

Investments in state-of-the-art instruments, platforms, information technology, databases, and other tools that uphold U.S. S&E leadership and that enable diverse communities of researchers, educators and students working at the S&E frontier.

Infrastructure and Instrumentation
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Advanced Networking Infrastructure	$46.62	$23.06	$22.90	-$0.16	-0.7%
Major Research Instrumentation	83.45	109.35	90.00	-19.35	-17.7%
National STEM Digital Library	27.63	24.40	27.02	2.62	10.7%
Research Resources[1]	153.66	160.79	181.09	20.30	12.6%
Science Resource Statistics	25.30	23.92	23.92	0.00	0.0%
Total, Infrastructure & Instrumentation	$336.66	$341.52	$344.93	$3.41	1.0%

[1]Research Resources in the FY 2004 Request included an additional $20.0 million in cyberinfrastructure, which has been placed under the Partnerships for Advanced Computational Infrastructure (PACI) facilities program.

NSF will consider annual performance goals related to the Infrastructure and Instrumentation investment goal appropriate for inclusion in a future performance budget at the time the PART analysis for this program is completed.

Advanced Networking Infrastructure (ANI)

Advanced Networking Infrastructure activities enable and expand scholarly communication and collaboration by providing researchers and educators with network access to high performance, remote scientific facilities including supercomputer facilities and information resources. In FY 2005, Advanced Networking Infrastructure will emphasize new projects in the NSF Middleware Initiative that develop new capabilities for distributed systems and demonstrate the use of new capabilities in realistic applications from science and engineering disciplines. Support will continue for new awards for international connectivity with an emphasis on strategic linkages that foster the most important international science and engineering collaborations. NSF's request for Advanced Networking Infrastructure in FY 2005 is $22.90 million, a decrease of $160,000 from the FY 2004 Estimate of $23.06 million.

Major Research Instrumentation (MRI)

The Major Research Instrumentation program is designed to improve access to state-of-the-art scientific and engineering equipment for research and research training in our nation's academic institutions. This program seeks to foster the integration of research and education by providing instrumentation for research-intensive learning environments. In FY 2005, NSF requests $90.0 million, a decrease of $19.35 million from the FY 2004 Estimate of $109.35 million, for continued support of the acquisition and development of research instrumentation for academic institutions. While the overall program may

decrease, emphasis will be placed on ensuring the availability of cutting-edge research instrumentation to a broad set of academic institutions, including undergraduate institutions, minority-serving institutions, and community colleges. To facilitate broader participation in the MRI program, NSF will significantly reduce or eliminate the MRI cost-sharing requirement for small and minority institutions.

National STEM Education Digital Library (NSDL)

A National STEM Education Digital Library (NSDL) responds to needs articulated by the NSF, the academic community, and corporate leaders for accelerating improvements in science, technology, engineering and mathematics (STEM) education. The NSDL, capitalizing on recent developments in digital libraries, will provide: a forum for the merit review and recognition of quality educational resources; a mechanism for electronic dissemination of information about high-quality educational materials, pedagogical practices, and implementation strategies; a centralized registry and archive for educational resources; and a resource for research in teaching and learning. In addition, the NSDL will provide an infrastructure to support and accelerate the impact of NSF programs. For example, developers of curricula and courses will benefit from awareness and knowledge of extant instructional materials, as well as information on their implementation. NSF support for the NSDL in FY 2005 totals $27.02 million, an increase of $2.62 million over the FY 2004 Estimate of $24.40 million.

Research Resources

Research Resources supports a range of activities throughout the Research and Related Activities Account including: multi-user instrumentation; mid-scale instrumentation, the development of instruments with new capabilities, improved resolution or sensitivity; upgrades to field stations and marine laboratories; support of living stock collections; facility-related instrument development and operation; and the support and development of databases and informatics tools and techniques and other domain-specific cyberinfrastructure. These various resources provide the essential platforms and tools for effective research in all areas of science and engineering. In FY 2005, funding for Research Resources totals $181.09 million, an increase of $20.30 million over the FY 2004 Estimate of $160.79 million. Most of this increase represents investments in domain-specific cyberinfrastructure.

Science Resources Statistics (SRS)

Science Resources Statistics (SRS) provides researchers and policymakers with data and information that is the basis for making informed decisions and formulating policy about the nation's science, engineering and technology enterprise. The primary statistical series produced by the SRS Subactivity (SBE) includes the education and employment of scientists and engineers and the performance and financial support of research and development. NSF is requesting $23.92 million for FY 2005, the same as the FY 2004 Estimate. Funding enables NSF to fulfill its statutory mandate to produce data and analysis on the scientific and engineering enterprise, provides funds to support survey redesign activities, quality improvement projects and begin feasibility and development activities related to research instrumentation and postdoctorates.

POLAR TOOLS, FACILITIES AND LOGISTICS

Investments that provide state-of-the-art tools, facilities and other infrastructure to enable world-class polar research and education.

Polar Tools, Facilities and Logistics
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Antarctic Facilities and Operations	$141.43	$149.48	$153.96	$4.48	3.0%
Polar Logistics	98.84	99.47	100.19	0.72	0.7%
Antarctic Logistics	*68.55*	*68.07*	*68.07*	*0.00*	*0.0%*
Arctic Logistics	*30.29*	*31.40*	*32.12*	*0.72*	*2.3%*
South Pole Station[1]	12.69	1.29	0.00	-1.29	-100.0%
Total, Polar Tools, Facilities and Logistics	$252.96	$250.24	$254.15	$3.91	1.6%

[1]South Pole Station includes initial support for operations and maintenance funded through R&RA as well as construction, acquisition and commissioning costs funded through MREFC. For a complete discussion of South Pole Station, please refer to the MREFC chapter.

NSF will consider annual performance goals related to the Polar Tools, Facilities and Logistics investment goal appropriate for inclusion in a future performance budget at the time the PART for this program is completed.

Antarctic Facilities and Operations

Project Description: Antarctic Facilities and Operations provide the basic infrastructure and transportation support for all U.S. research conducted in Antarctica, including that funded by U.S. mission agencies, for year-round work at three U.S. stations, two research ships, and a variety of remote field camps. All life support is provided by NSF, including facilities infrastructure, communications, and utilities (water and power), and health and safety infrastructure.

Principal Scientific Goals: Antarctic Facilities and Operations provides science support in Antarctica, ranging from astrophysics to microbiology and climatology; provides environmental stewardship, and maintains U.S. presence in Antarctica in accord with U.S. policy.

Principal Education Goals: By maintaining and operating the three U.S. stations in Antarctica, Antarctic Facilities and Operations support all scientific work performed by U.S. scientists in Antarctica. Specific science and education goals are managed by the science programs.

Partnerships and Connections to Industry: Raytheon Polar Services Company is the primary support contractor, which oversees approximately 385 separate subcontractors for supplies and technical services.

Management and Oversight: The Office of Polar Programs (OPP) has the overall management responsibility for Antarctic Facilities and Operations. The performance of the support contractor is evaluated every year by an Award Fee Board, with representatives from OPP and the Budget, Finance and

Award Management. In addition, performance is reviewed by Committees of Visitors and the OPP Advisory Committee.

Antarctic Facilities and Operations also includes management of South Pole Station Modernization, an activity funded out of the Major Research Equipment and Facilities Construction (MREFC) Account from FY 1998 through FY 2005. The new station will provide the infrastructure required for imaginative new science on the drawing board.

Current Project Status: All three Antarctic stations are currently operating as normal.

Funding Profile: All funding for Antarctic Facilities and Operations has been provided through the R&RA Account. Support for South Pole Station Modernization, the South Pole Safety and Environment, and the Polar Aircraft Upgrades projects are found in the MREFC Section.

Antarctic Facilities and Operations Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994		104.54	104.54
FY 1995		104.67	104.67
FY 1996		107.35	107.35
FY 1997		100.29	100.29
FY 1998		97.80	97.80
FY 1999		102.03	102.03
FY 2000		108.11	108.11
FY 2001		117.96	117.96
FY 2002		126.15	126.15
FY 2003		143.93	143.93
FY 2004 Estimate		152.29	152.29
FY 2005 Request		155.14	155.14
FY 2006 Estimate		159.80	159.80
FY 2007 Estimate		164.60	164.60
FY 2008 Estimate		169.50	169.50
FY 2009 Estimate		174.60	174.60

NOTE: Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Operations and Maintenance: The Office of Polar Programs (OPP) contracts with a prime support contractor for science support, and operations and maintenance of the Antarctic stations and related infrastructure in New Zealand and Chile, as well as leasing of research vessels and fixed-wing aircraft used in support of research. The contractor is selected through a competitive bidding process. Other agencies and contractors also provide technical support in areas of expertise such as engineering, construction and communications.

Renewal or Termination: Not applicable to the facilities themselves. The current Antarctic support contract was recompeted and awarded in FY 2000. After a five-month phase-in period the contractor

assumed responsibility for operations in March 2000. The contract's ten year performance period is segregated into a five-year initial period and a five-year optional period. NSF is presently considering whether to exercise its option to extend the performance period.

Associated Research and Education Activities: The Antarctic infrastructure makes science in Antarctica possible - ranging from astrophysics to microbiology and climatology - and maintains U.S. presence in Antarctica in accord with U.S. policy. Research is funded through the Antarctic Research Grants Program at NSF and through other federal agencies funding research in Antarctica.

Science Support: OPP's prime support contractor provides science support, as well as operations and maintenance of the facilities.

Polar Logistics

Arctic research support and logistics is driven by and responsive to the science supported in U.S. Arctic Research programs. Funding for logistics is provided directly to grantees or to key organizations that provide or manage Arctic research support and logistics. Major components include: access to U.S. Coast Guard and other icebreakers, University-National Oceanographic Laboratory vessels and coastal boats, and support on the U.S. Coast Guard Cutter *Healy*; access to fixed and rotary-wing airlift support; upgrades at Toolik Field Station, University of Alaska, Fairbanks' field station for ecological research on Alaska's North Slope; safety training for field researchers and funding for field safety experts, global satellite telephones for emergency response, and improved logistics coordination; development of a network of strategically placed U.S. Long-Term Observatories linked to similar efforts in Europe and Canada; and installation of a modern local area network in Barrow/Naval Arctic Research Laboratory with improved access to the Internet.

U.S. Antarctic Logistical Support is provided by U.S. Department of Defense (DoD) components. Major elements include: Military personnel of the 109th Airlift Wing (AW) of the New York Air National Guard; 109th AW LC-130 flight activity and aircraft maintenance; transportation and training of personnel in connection with the U.S. Antarctic Program; logistics facilities of the Air Force Detachment 13 in Christchurch, New Zealand and the 109th Airlift Wing in Scotia, New York; air traffic control, weather forecasting, and electronic equipment maintenance; charter of Air Mobility Command Airlift and Military Sealift Command ships for the re-supply of McMurdo Station; fuel purchased from the Defense Logistics Agency; and use of Department of Defense satellites for communications.

NSF is requesting $100.19 million for Polar Logistics, an increase of $720,000 over the FY 2004 Estimate of $99.47 million. This increase in Arctic Logistics support, to $32.12 million, will provide continuing support for research projects throughout the Arctic including Alaska, Canada, the Arctic Ocean, Greenland, Scandinavia and Russia; support for Toolik Field Station, University of Alaska, Fairbanks' field station for ecological research on Alaska's North Slope; continuing support for a cooperative agreement with the Barrow Arctic Science Consortium to improve support and logistics in the area and make any new facilities useful for basic research programs. Support provided by DoD for the U.S. Antarctic Logistics program is level in FY 2005, at $68.07 million.

FEDERALLY-FUNDED RESEARCH AND DEVELOPMENT CENTERS (FFRDCS)

Investments in research, development, and R&D policy that create unique, important and long-term capabilities for the Federal government, in response to law, mandate or widely-recognized need.

Federally-Funded Research and Development Centers (FFRDCs)
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
National Astronomy R&D Centers	$100.68	$108.67	$98.91	-$9.76	-9.0%
National Astronomy & Ionosphere Center	*12.73*	*12.34*	*12.50*	*0.16*	*1.3%*
National Optical Astronomy Observatories	*42.62*	*41.35*	*39.00*	*-2.35*	*-5.7%*
National Radio Astronomy Observatories	*45.33*	*54.98*	*47.41*	*-7.57*	*-13.8%*
National Center for Atmospheric Research	80.27	83.27	84.52	1.25	1.5%
Science and Technology Policy Institute	3.97	3.98	4.00	0.02	0.5%
Total, FFRDC Support	$184.92	$195.92	$187.43	-$8.49	-4.3%

NSF will consider annual performance goals related to the Federally-Funded Research and Development Centers investment goal appropriate for inclusion in a future performance budget at the time the PART for this program is completed.

NATIONAL ASTRONOMY CENTERS – NAIC, NOAO and NRAO

National Astronomy and Ionosphere Center (NAIC)

Project Description: The NAIC is a visitor-oriented national research center, supported by NSF and focusing on radio and radar astronomy and atmospheric sciences. Its principal observing facility is the world's largest radio/radar telescope, a 305m-diameter spheroid constructed within a karst depression in western Puerto Rico near the town of Arecibo. The facility itself is called the Arecibo Observatory. The NAIC is operated by Cornell University for NSF under a cooperative agreement. NAIC provides telescope users with a wide range of research and observing instrumentation. The center has a permanent staff of scientists, engineers, and technicians who are available to help visiting investigators with their observation programs.

Principal Scientific Goals: The NAIC was founded to advance the study of basic research in Radio Astronomy, Solar System Radar Astronomy, and Ionospheric Physics.

Principal Education Goals: NAIC's primary education goal is to support and enhance the education of graduate and undergraduate student researchers. Arecibo was one of NSF's first sites for the Research Experiences for Undergraduates (REU) program. At Arecibo, graduate students receive training through use of the facility for Ph.D. research. NAIC also sponsors a major outreach program in Puerto Rico via a modern Visitor's Center, a new Learning Center, and summer workshops for K-12 teachers. In addition NAIC holds, in collaboration with NRAO, a summer school on single-dish radio astronomy techniques. This is a continuing bi-yearly school alternating between NRAO sites and Arecibo.

Partnerships and Connections to Industry: NAIC currently has partnerships with NASA, NRAO, Penn State and other Universities, and the Angel Ramos Foundation of Puerto Rico (a private organization).

Management and Oversight: NAIC is one of four National Centers in astronomy supported by the Astronomical Sciences Subactivity (MPS). Management is through a cooperative agreement with Cornell University. This agreement requires that an annual progress report and program plan be submitted to and approved by NSF. Bi-weekly teleconferences are maintained between the NSF program manager and the NAIC Director. The program manager visits the Observatory several times per year. The NSF program manager attends Arecibo Visiting Committee meetings (commissioned by Cornell), and committee reports are made available to NSF. NAIC/Cornell representatives present yearly status reports and long-range plans during visits to NSF. Management reviews by external review panels for NSF are held typically three years into a 5-year cooperative agreement.

Current Project Status: The current cooperative agreement with Cornell to manage NAIC expires in September 2004. A solicitation for the management of NAIC was issued in November 2003; the due date for proposals is March 12, 2004. The FY 2005 Request for NAIC totals $10.60 million, an increase of $60,000 relative to the FY 2004 Estimate of $10.54 million.

Funding Profile: All funding for NAIC to date has been provided through the R&RA Account.

NAIC Funding Profile
(Dollars in millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994	$1.30	$7.40	$8.70
FY 1995	0.40	7.30	7.70
FY 1996	0.60	7.70	8.30
FY 1997	0.40	8.20	8.60
FY 1998	0.40	7.80	8.20
FY 1999	0.50	8.80	9.30
FY 2000		8.80	8.80
FY 2001	1.10	9.00	10.10
FY 2002		9.40	9.40
FY 2003		10.93	10.93
FY 2004 Estimate		10.54	10.54
FY 2005 Request		10.60	10.60
FY 2006 Estimate		10.60	10.60
FY 2007 Estimate		10.60	10.60
FY 2008 Estimate		10.60	10.60
FY 2009 Estimate		10.60	10.60

The current Cooperative Agreement expires in FY 2004. Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available. GEO contributions for science support are not included.

Information pertaining to the data in the table is included below.

- Implementation: All construction and commissioning occurred before this reporting period. Construction of the Arecibo Observatory by the Air Force was completed in 1963. NSF took

over funding for operations in 1970. The primary NSF-funded upgrade during the period reported was installation of a Gregorian feed system to enhance telescope efficiency and increase useable bandwidth.

The Arecibo Observatory is part of the National Astronomy and Ionosphere Center (NAIC), a national research center operated by Cornell University under a cooperative agreement with the National Science Foundation. As the site of the world's largest single-dish radio telescope, the Observatory is recognized as one of the most important national centers for research in radio astronomy, planetary radar and terrestrial aeronomy.

- Operations and Maintenance: In-house research accounts for about 6 percent of the total operations budget of NAIC. Most of this research concerns traditional radio-astronomical observations (interstellar gas, galaxies, pulsars) and radar astronomy of solar system objects (asteroids, planetary surfaces and moons). This research furthers the scientific mission of the facility and maintains a scientifically competent staff. The planetary radar program, which has been funded by NASA since 1974, is in a period of transition. NASA has decided to ramp down and then terminate its support by the end of FY 2005. The FY 2004 Estimate and the FY 2005 Request include $300,000 for NSF support of the program.

Renewal or Termination: The current cooperative agreement with Cornell to manage NAIC expires in September 2004, and NSF has decided to recompete the award. A solicitation has been issued for an award covering the period FY 2005-2009.

Associated Research and Education Activities: Teacher training is conducted in intensive workshops, held in the past at the Visitor's Center, and as of 2002 in the new Learning Center (both built with funding from the Angel Ramos Foundation of Puerto Rico). Arecibo attracts roughly 110,000 visitors per year, with many K-12 school groups visiting from across the island. Many graduate students use NAIC for dissertation research and Research Experiences for Undergraduates (REU) students also use the telescope as part of their summer research experience. Support for REU is at the level of roughly $40,000 per year.

Science Support: In addition to MPS funding, the Atmospheric Sciences subactivity in the Geoscience Activity expects to provide $1.80 million in FY 2004 and $1.70 million in FY 2005 for ionospheric research and staff support. NSF does not provide individual investigator awards targeted specifically for use of NAIC. Many users are supported through NSF or NASA grants which pursue scientific programs that require use of NAIC.

National Optical Astronomy Observatory (NOAO)

Project Description: The National Optical Astronomy Observatory was established in 1982 by uniting the operations of the Kitt Peak National Observatory in Arizona and the Cerro Tololo Inter-American Observatory in Chile. NOAO is a federally funded research and development center (FFRDC) for research in ground-based nighttime optical and infrared astronomy. NOAO also represents the U.S. astronomical community in the International Gemini Observatory. The National Solar Observatory (NSO), once administratively part of NOAO but now with an independent management structure, makes

available to qualified scientists the world's largest collection of optical and infrared solar telescopes and auxiliary instrumentation for observation of the solar photosphere, chromosphere, and corona. The NSO operates facilities in Sunspot, New Mexico and Tucson, Arizona. As national facilities, NOAO and NSO telescopes are open to all astronomers regardless of institutional affiliation on the basis of peer-reviewed observing proposals.

Principal Scientific Goals: To support basic research in astronomy and solar physics by providing the best ground-based astronomical telescopes to the nation's astronomers, promoting public understanding and support of science, and advancing all aspects of U.S. ground-based astronomical research.

Principal Education Goals: To promote and enhance the education of undergraduate and graduate student researchers and outreach training and curriculum development for K-12 teachers. Approximately 15 percent of all NOAO and NSO users are graduate students. Some recent examples of outreach activities include: Project ASTRO, which matches astronomers with 4th to 9th grade teachers and community educators in the Tucson and Sunspot areas who want to enrich their astronomy and science teaching; and the use of Astronomy in the Teacher Leaders in Research-Based Science Education (TLRBSE), a summer workshop for middle and high school teachers.

Partnerships and Connections to Industry: Thirty U.S. Member Institutions and six International Affiliate Members comprise the Member Institutions of the Association of Universities for Research in Astronomy (AURA), Inc, the management organization for NOAO. Other partners include the USAF Office of Scientific Research, NASA, and industrial vendors. Development of new telescopes, instrumentation, and sensor techniques is done in partnership with relevant industry, through subawards to various large and small aerospace, optical fabrication, and IT companies.

Management and Oversight: Management is through a cooperative agreement with AURA. Separate Directors for NOAO and NSO report to the President of AURA. Oversight is through detailed annual program plans and long range plans for NOAO and NSO, plus quarterly and annual reports. NSF has periodic reviews of AURA management by external committees. Ongoing oversight and evaluation is by an assigned NSF program director (AST/MPS) and by a standing external committee for NOAO.

Current Project Status: Cooperative agreements for continuing management and operations are for terms of five years; a new agreement was recently competed and awarded to AURA October 1, 2002. A management review will be carried out three years into the current cooperative agreement. The FY 2005 Request for NOAO totals $39.0 million, an decrease of $2.35 million from the FY 2004 Estimate of $41.35 million. NOAO funding includes $35.0 million for NOAO and NSO telescopes, plus $4.0 million for the Telescope System Instrumentation Program (TSIP), which is administered for the community through NOAO. TSIP is a program to unify the privately held and the national optical and IR observatory facilities by funding instrument development and construction at the private observatories in return for observing time on those facilities which is in turn allocated to the astronomical community at large on the basis of peer-reviewed observing proposals. NSO is nearing the completion of the design and development phase for the Advanced Technology Solar Telescope (ATST) and has submitted a proposal for its construction in late calendar year 2003. NOAO is actively participating in the development of both the Giant Segmented Mirror Telescope and the Large Synoptic Survey Telescope, both of which are high priority recommendations of the Decadal Survey conducted by the NRC's Astronomy and Astrophysics Survey Committee.

Funding Profile: All funding for NOAO to date has been provided through the R&RA Account.

NOAO Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	NSF Total
FY 1994		$28.60	$28.60
FY 1995		29.00	29.00
FY 1996		27.10	27.10
FY 1997		28.00	28.00
FY 1998	$3.00	27.90	30.90
FY 1999	1.40	28.70	30.10
FY 2000	1.40	28.70	30.10
FY 2001		31.20	31.20
FY 2002[1]		36.82	36.82
FY 2003		42.62	42.62
FY 2004 Estimate		41.35	41.35
FY 2005 Request		39.00	39.00
FY 2006 Estimate		39.00	39.00
FY 2007 Estimate		39.00	39.00
FY 2008 Estimate		39.00	39.00
FY 2009 Estimate		39.00	39.00

[1]Beginning in FY 2002, TSIP is funded at $4.0 million.

NOTE: The current cooperative agreement expires in FY 2006. Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Implementation: All construction and commissioning of major telescopes occurred before this reporting period. Recent upgrades have been made in the National Solar Observatory facilities, with the completion and commissioning of the Synoptic Optical Long-term Investigations of the Sun (SOLIS) telescope in 2003.

- Operations and Maintenance: The management and operations budget primarily maintains and utilizes existing facilities and develops new instrumentation for existing telescopes in support of research by the national astronomical community. Basic research by in-house scientific staff accounts for approximately 5 percent of the total budget.

Renewal or Termination: The current cooperative agreement expires in FY 2006. A management review of the cooperative agreement will be carried out during FY 2004, on the basis of which NSF will decide whether to renew or recompete the program. Funding amounts for FY 2007 and beyond will be determined through negotiation based on proposals received at this time.

Associated Research and Educational Activities: Teacher training includes participation of more than 350 teachers in Project ASTRO; intensive (multi-week) training of about 25 teachers per year through Teacher Learning through Research Based Science Education; and Research Experience for Teachers. K-12

numbers are not tracked but it is estimated that school groups make up about 10 percent of the roughly 85,000 visitors per year to public visitor centers at NOAO and NSO. Instructional materials are developed in collaboration with the Lawrence Hall of Science Great Explorations in Math and Science (GEMS) program. The "Hands on Optics" program, aimed at middle school students, is being developed by NOAO in collaboration with the Optical Society of America and the International Society for Optical Engineering. Observational facilities are also used by approximately 200 graduate students each year and by undergraduate students participating in the REU program.

Science Support: In addition to the funds listed above, approximately $500,000 per year is provided in total from the Division of Elementary, Secondary and Informal Education (EHR), the Division of Atmospheric Sciences (GEO), the Program for Education and Special Programs in the Astronomy Division (REU and teacher enhancement) (MPS), and the Off ice of International Science and Engineering (OISE). For all NOAO and NSO telescopes, a peer-review telescope allocation committee provides merit-based telescope time but no financial support. NSF does not provide awards targeted specifically for use of NOAO. Most users are supported through NSF or NASA grants to pursue scientific programs that require use of NOAO.

National Radio Astronomy Observatory (NRAO)

Project Description: The National Radio Astronomy Observatory (NRAO) is a federally-funded research and development center (FFRDC) that provides state-of-the-art radio telescope facilities for use by the scientific community. NRAO conceives, designs, builds, operates and maintains radio telescopes used by scientists from around the world to study virtually all types of astronomical objects known, from planets and comets in our own Solar System to quasars and galaxies billions of light-years away. NRAO operates major radio telescopes at Green Bank, West Virginia, at Socorro, New Mexico, and at ten telescope array sites spanning the U.S. from the Virgin Islands to Hawaii. NRAO's headquarters are in Charlottesville, Virginia. These federally funded, ground-based observing facilities for radio astronomy are available to any qualified astronomer, regardless of affiliation or nationality, on the basis of scientific peer-reviewed proposals.

Principal Scientific Goals: NRAO supports and advances basic research in the astronomical sciences, including understanding: the geometry and the matter content of the universe; the formation of galaxies, stars and planets; and the nature of black holes.

Principal Education Goals: NRAO supports and enhances the education of undergraduate and graduate student researchers and outreach training for K-12 teachers. The primary education goal is to support the development of a scientifically and technically literate society through a comprehensive outreach program in which information about radio astronomy is made available to the public through the world-wide web and news media. NRAO sites support visitor/education centers; and educational programs are developed in partnership with other institutions. NRAO also supports undergraduate, graduate and post-doctoral students in radio-astronomy scientific research, the design, construction, test and implementation of innovative scientific instruments and telescopes for radio-astronomy and of software tools for the scientific data analysis and for the interpretation of radio-astronomical data.

Partnerships and Connections to Industry: To make the observations needed to sustain radio astronomy research, 2000 scientists from over 150 institutions around the world partner with NRAO. Numerous other U.S. universities, NASA, foreign scientific and technical institutes and industrial vendors are also partners. The development of new telescopes, instrumentation, and sensor techniques is completed in partnership with relevant industry, through competitive subawards to various large and small aerospace

companies, radio antenna manufacturing firms, and specialized electronics and computer software companies.

Management and Oversight: Management is through a cooperative agreement with Associated Universities Incorporated (AUI). The NRAO director reports to the President of AUI. Oversight is through detailed annual program plans and long range plans for NRAO, plus quarterly and annual reports. NSF has periodic reviews of AUI management by external committees. Ongoing oversight and evaluation is by an assigned NSF program director (AST/MPS) and by a standing external committee for NRAO.

Current Project Status: Cooperative agreements for continuing management and operations are for terms of five years. The current agreement expires on September 30, 2004. A recent management review led to the recommendation, approved by the National Science Board, that AUI continue as managing organization of NRAO during the period of the next cooperative agreement. The renewal proposal from AUI for operations of NRAO currently under review will form the basis of a new 5-year cooperative agreement. The NRAO is engaged currently in two construction projects: the Expanded Very Large Array (EVLA) and the international Atacama Large Millimeter Array (ALMA), a millimeter/submillimeter interferometer which was approved as a Major Research Equipment and Facilities Construction project by the National Science Board in winter 2001. NRAO is the U.S. implementing organization of the ALMA project. The FY 2005 Request for NRAO totals $47.41 million, a decrease of $7.57 million from the FY 2004 Estimate of $54.98 million, which included a one time funding increment for major repairs to the Green Bank telescope track structure and accelerated work on the EVLA.

Funding Profile: All funding for NRAO to date, excluding construction funding for ALMA, which is managed by NRAO, has been provided through the R&RA Account.

NRAO Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994		$29.00	$29.00
FY 1995		29.40	29.40
FY 1996		29.60	29.60
FY 1997		30.70	30.70
FY 1998		31.50	31.50
FY 1999		33.00	33.00
FY 2000		33.10	33.10
FY 2001	$5.00	47.10	52.10
FY 2002	5.00	35.43	40.43
FY 2003	5.00	40.33	45.33
FY 2004 Estimate[1]	9.34	45.64	54.98
FY 2005 Request	6.34	41.07	47.41
FY 2006 Estimate	5.00	41.50	46.50
FY 2007 Estimate	5.00	41.50	46.50
FY 2008 Estimate	4.32	41.50	45.82
FY 2009 Estimate	0.00	41.50	41.50

[1]The current cooperative agreement expires in FY 2004. Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Implementation: All construction and commissioning of NRAO telescopes occurred before this reporting period. The Observatory is now engaged in a major upgrade to the 25-year-old Very Large Array (VLA) radio telescope located in Soccoro, NM, a project known as the Expanded Very Large Array (EVLA).

- Operations and Maintenance: Funding for management, operations and maintenance primarily maintains and utilizes existing facilities and develops new instrumentation for existing telescopes in support of research by the national astronomical community. Basic research by in-house staff is less than 5 percent of the total budget.

- ALMA operations: The funding profile for the ALMA activity includes early operations funding beginning in FY 2005 at $1.0 million. These additional funds are not explicitly included in the table above, but are expected to be part of the NRAO operating expenditures beginning in FY 2005.

Renewal or Termination: The current cooperative agreement expires in FY 2004. A renewal proposal from AUI for operations of NRAO will form the basis of a new 5-year cooperative agreement and funding amounts for FY 2005 and beyond will be determined through negotiation at that time.

Associated Research and Education Activities: NRAO conducts an active educational and public outreach program. The observatories host a combined total of approximately 50,000 visitors each year to the Green Bank and Very Large Array facilities, including school field trips for K-12 students. The Green Bank observatory recently completed the construction of a bunkhouse to house student groups on overnight trips. Observatory professional scientific and engineering staff also visit classrooms regularly to provide special instruction in the astronomical and radio sciences. Observational facilities are used by graduate students carrying out dissertation research and those on work experience programs and by undergraduate students participating in the REU program.

Science Support: In addition to the funding listed above, approximately $500,000 per year is provided in total from the Division of Elementary, Secondary and Information Education in EHR and the Program for Education and Special Programs in the Astronomy Division. A peer-review telescope allocation committee provides merit-based telescope time but no financial support. NSF does not provide individual investigator awards targeted specifically for use of NRAO. Many users are supported through NSF or NASA grants to pursue scientific programs that require use of NRAO.

National Center for Atmospheric Research (NCAR)

Project Description: National Center for Atmospheric Research (NCAR) is a federally-funded research and development center (FFRDC) serving a broad research community, including atmospheric scientists, as well as researchers in complementary areas of the environmental and geosciences. Facilities available to university, NCAR, and other researchers include a world-class supercomputing facility providing services well suited for the development, validation and execution of large computational models in the atmospheric, oceanic and related sciences. NCAR is also responsible for the curation, archiving and manipulation of large data sets and NCAR's aviation infrastructure provides research aircraft, which can be equipped with sensors to measure dynamic physical and chemical states of atmospheric phenomena at local, regional and global scales. In addition, airborne and portable ground-based radar systems are available for atmospheric research as are other surface sensing systems. NCAR operates the several facilities of the High Altitude Observatory (HAO), which are dedicated to the study of the sun, solar

phenomena, space weather, and the responses of the upper atmosphere to the sun's output. As a NSF sponsored facility, NCAR is committed to the dissemination of newly discovered knowledge in all the above areas.

Principal Scientific Goals: As an internationally recognized center of excellence, NCAR scientific research programs include focus on the following areas: large-scale atmospheric and ocean dynamics that contribute to an understanding of the past and present climate processes and global climate change, including interactions with other of the Earth's environmental systems; global and regional atmospheric chemistry including atmospheric connections to geochemical and biogeochemical cycles; the variable nature of the Sun and the physics of the corona and their interaction with the earth's magnetic field; the physics of clouds, thunderstorms, precipitation formation, and the interactions and effects on larger-scale weather; and the examination of human society's impact on and response to global environmental change. In addition, NCAR provides fellowships, internships, workshops and colloquia for a complete range of visiting scientists to conduct research and interact with NCAR scientists.

Principal Education Goals: NCAR disseminates knowledge of the geosciences to the general public, K-12 schools, teachers and students, to undergraduate, and graduate institutions, to postdoctoral and career scientists and researchers, as well as to policy and decision-makers. One way this is achieved is through educational tours and exhibits reaching tens of thousands of people every year. Professional training courses, innovative and award-winning science education websites, as well as the directed activities of the Office of Education and Outreach, are further examples of how NSF's goal of integrating research and education is attained through NCAR activities.

Connections to Industry: NCAR works to develop new collaborations and partnerships with the private sector through directed research and technology transfer. These activities span improved capabilities for detecting, warning and forecasting mesoscale weather phenomena of economic and social importance to the private and public sectors to longer term economic consideration of climate change issues.

Partnerships: Research collaborations among NCAR staff and university colleagues are integral to its success as an institution, and as a focus and meeting point for the broader atmospheric and related sciences community. NCAR fosters and strongly supports these interactions through many approaches devised and refined over the course of 43 years. Notable recent examples include the community models, extensive collaboration with university partners (e.g., 538 peer-reviewed papers in FY 2003, which were co-authored by NCAR and university-based scientists), and extensive collaboration with non-academic scientists nationally and internationally.

Management and Oversight: NCAR is currently managed by the University Corporation for Atmospheric Research (UCAR), a university-governed and university-serving organization comprised of over 68 Ph.D. granting academic institutions, with NCAR as its major engine of basic and applied research. UCAR works in partnership with NSF, the university community, and its other research sponsors such as NASA, NOAA, DOE, EPA, and the FAA whenever such research collaboration enhances NCAR's basic NSF-supported research goals or facilities missions. NSF's Division of Atmospheric Sciences (GEO) along with Budget, Finance and Award Management (BFA), provide cognizant oversight of this facility via a cooperative agreement with the managing institution, UCAR.

Current Project Status: With the completion of a strategic plan "*NCAR as Integrator*," in FY 2001, NCAR embarked on plan to implement 27 strategic initiatives that collectively have a wide-ranging scientific scope. Examples include the water cycle across scales, biogeosciences, data assimilation, and undergraduate leadership workshops. In addition, NCAR is managing the acquisition of the Major Research Equipment and Facilities Construction (MREFC) project High-Performance Instrumented Airborne Platform for Environmental Research (HIAPER). UCAR contracted with Gulfstream, Inc. and Lockheed-Martin to procure a modified G-V aircraft that should be ready for scientific operation in FY

2005. (For further information on the capabilities of HIAPER, see the MREFC chapter). In FY 2005, NSF requests funding of $84.52 million for NCAR, an increase of $1.25 million over the FY 2004 Estimate of $83.27 million.

Funding Profile: All funds for NCAR during this time frame have been provided through the R&RA Account.

NCAR Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994	$0.85	$54.90	$55.75
FY 1995	3.95	59.60	63.55
FY 1996	3.90	59.50	63.40
FY 1997	3.88	59.30	63.18
FY 1998	3.42	60.30	63.72
FY 1999	7.47	64.10	71.57
FY 2000	7.50	64.70	72.20
FY 2001	7.53	70.50	78.03
FY 2002	3.75	73.84	77.59
FY 2003	4.50	75.77	80.27
FY 2004 Estimate[1]	4.61	78.66	83.27
FY 2005 Request	4.73	79.79	84.52
FY 2006 Estimate	4.85	82.80	87.65
FY 2007 Estimate	4.97	87.00	91.97
FY 2008 Estimate	5.00	90.80	95.80
FY 2009 Estimate	5.10	92.40	97.50

[1]The current cooperative agreement expires in FY 2008. Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Implementation: In FY 1999-2003, a project to refurbish the Mesa Lab building located in Boulder, CO was funded and project tasks undertaken. The refurbishment included long-sought upgrades of various facets of NCAR's Mesa Lab facilities such as handicap accessibility, wiring systems, structural and utilities upgrades, and has been completed.

- Operations and Maintenance: This funding supports the operation of the NCAR facilities, including supercomputers, instrumented research aircraft and associated flight costs, and ground-based portable observing systems. Routine maintenance costs of the aircraft and facilities are also covered under this category. In addition, approximately half of the management, operations and maintenance amount is used to support science conducted by NCAR scientists.

Renewal or Termination: The management of NCAR will be competed before the end of the current cooperative agreement, September 30, 2008. In addition, a mid-award review of both science activities as well as management effectiveness will be performed. Future funding levels beyond FY 2005 will be dependent on the outcome of those reviews and on the continuous oversight provided by NSF. Proposals for the next funding award, beyond FY 2008, will be subject to NSF's standard merit review procedures,

and will be reviewed by both individual expert reviewers as well as a focus panel composed of preeminent researchers and managers

Associated Research and Education Activities: NCAR employs a large number of scientists who pursue research objectives individually and in groups. In addition, numerous external researchers use NCAR facilities to further their research objectives. NCAR has recently created an expanded and updated visitor area where various hands-on displays for K-12 when school-children or citizens come to visit the Mesa Laboratory. Lectures and demonstrations are also provided for visiting students and teachers. Teachers listed in the table below are those K-12 instructors coming to attend a workshop or bring students to learn about atmospheric sciences. Undergraduate and graduate students are those who arrive at NCAR for a temporary stay to do specific research that usually lasts three months to a year or two at most.

Direct Impact of NCAR's Participation in Education Activities

Year	K-12	Undergrad	Graduate	Teachers
FY 1994	3,799	*23*	*66*	108
FY 1995	8,477	*23*	*66*	100
FY 1996	5,926	*25*	*65*	47
FY 1997	7,067	*25*	*67*	32
FY 1998	7,063	*26*	*68*	264
FY 1999	9,569	*24*	*69*	90
FY 2000	9,894	*24*	*69*	92
FY 2001	8,995	23	63	101
FY 2002	9,424	*67*	*57*	865[a]
FY 2003	7,295[a,b]	*85*	*109*	815[a]

NOTE*: All numbers in italics are estimates.*

[a] The increased number of teachers in FY 2002 includes participants at a series of workshops.

[b] The decreased number in FY 2003 reflects partial closure of Mesa Lab facilities tours during refurbishment.

Science Support: NSF-supported researchers with grants totaling approximately $22.0 million per year used the aircraft and observational facilities operated by NCAR in FY 2003. This support comes from programs within the Atmospheric Sciences Subactivity for proposals submitted for use of the NSF aircraft, operated and maintained by NCAR, during field campaigns. Additional use of NCAR observational facilities by other NSF-funded activities such as oceanography and polar programs, along with NSF wide priority areas such as Biocomplexity in the Environment, also contribute to this support. NSF-supported researchers with grants totaling approximately $30.0 million per year used the computational resources of NCAR for a wide range of modeling, simulation and data assimilation tasks. Many principal investigators additionally request computing time at the NCAR facility to accomplish analyses required to evaluate results from their completed field and observational work.

Science and Technology Policy Institute (STPI)

The Science and Technology Policy Institute (STPI), a federally funded research and development center (FFRDC), provides analytical support to the Office of Science and Technology Policy (OSTP) to identify near-term and long-term objectives for research and development, and identifies options for achieving

those objectives. NSF is requesting $4.0 million in FY 2005, an increase of $20,000 over the FY 2004 Estimate, which includes $1.0 million for database activities in support of STPI operations.

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION PROJECTS

The MREFC Account supports the acquisition, construction and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Projects supported by this account are intended to extend the boundaries of technology and open new avenues for discovery for the science and engineering community. Initial planning and design, and follow on operations and maintenance costs of the facilities are provided through the Research and Related Activities (R&RA) and Education and Human Resources (EHR) Accounts.

The National Science Board (NSB) reviews and approves potential MREFC projects for inclusion in future budget requests. The NSF Director, after discussion with OMB, then selects from the group of NSB-approved projects those appropriate for inclusion in a budget request to the Congress. Funding is requested in this Budget Request for all projects approved by the NSB to date. In FY 2005, funding is requested for the highest priority items, the ongoing projects identified in the following table, and for three new starts. In addition, a further two new starts are requested in FY 2006. In priority order, these new projects are:

- National Ecological Observatory Network ($12.0 million in FY 2005)
- Scientific Ocean Drilling Vessel ($40.85 million in FY 2005)
- Rare Symmetry Violating Processes ($30.0 million in FY 2005)
- Ocean Observatories ($24.76 million in FY 2006)
- Alaska Regional Research Vessel ($49.32 million in FY 2006)

A total of $213.27 million is requested in FY 2005, an increase of $58.30 million over the FY 2004 Estimate, to support three ongoing projects, and three new starts. Additional information on these projects, and the later year starts can be found in the MREFC chapter.

MREFC Funding
(Dollars in Millions)

Projects[1]	FY 2003[2] Actual	FY 2004 Estimate	FY 2005 Request
Atacama Large Millimeter Array Construction	29.81	50.70	49.67
EarthScope: USArray, SAFOD, PBO	29.81	43.24	47.35
High-Performance Instrumented Airborne Platform for Environmental Research (HIAPER)	13.00		
IceCube Neutrino Observatory	25.75	41.75	33.40
Large Hadron Collider (LHC)	9.69		
Network for Earthquake Engineering Simulation (NEES)	13.47	8.05	
South Pole Station	12.69	1.29	
Terascale Computing Systems	44.83	9.94	
National Ecological Observatory Network (NEON)			12.00
Scientific Ocean Drilling Vessel (SODV)			40.85
Rare Symmetry Violating Processes (RSVP)			30.00
Total, Major Research Equipment and Facilities Construction (MREFC) Account	$179.03	$154.97	$213.27

Totals may not add due to rounding.
[1] Does not include funding provided for early concept and development or follow-on operations and maintenance. These funds are provided through the Research and Related Activities and Education and Human Resources Accounts.
[2]FY 2003 Actuals include $35.0 million in carryover from prior year appropriations for Terascale Computing Systems due to the NSB meeting schedule. The award was approved in October 2002, and the funds were subsequently obligated. $66.06 million appropriated in FY 2003 is carried over into FY 2004 for HIAPER ($12.53 million), the IceCube Neutrino Observatory ($3.67 million), the Large Hadron Collider ($33,819), the Polar Projects ($49.71 million) and Terascale Computing Systems ($107,959). This FY 2003 carryover will be reflected in the FY 2004 Current Plan.

- Atacama Large Millimeter Array (ALMA) Construction (Phase II) is the construction phase of the ALMA project, begun in FY 2002 and supported by international partnership through NSF. ALMA is planned as a millimeter wave interferometer made up of 64 12-meter antennas and will be an aperture-synthesis radio telescope operating in the wavelength range from 3 mm to 0.4 mm.

- EarthScope is planned as a distributed, multi-purpose geophysical instrument array that will make major advances in our knowledge and understanding of the structure and dynamics of the North American continent. The three components of the project are the USArray, the San Andreas Fault Observatory at Depth (SAFOD), and the Plate Boundary Observatory (PBO).

- IceCube is planned as an extension of the successful AMANDA project. It will be a neutrino observatory that uses one cubic kilometer of the Antarctic ice sheet as the detector medium. IceCube will open a new astronomical window, giving us hitherto unseen views of the most active and energetic astrophysical objects, and it will complement the existing and planned instruments funded by NSF, NASA and others.

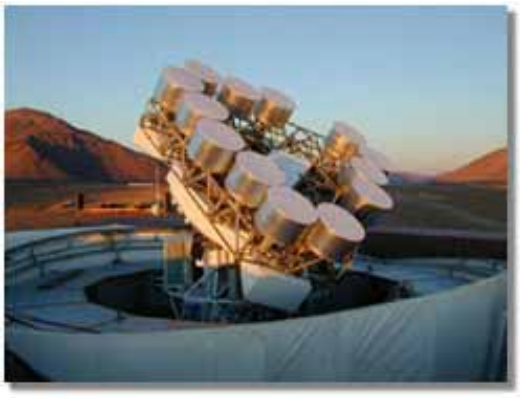
- National Ecological Observatory Network (NEON) will be a continental scale research instrument consisting of 17 geographically distributed observatories, networked via state-of-the-art communications, for integrated studies to obtain a predictive understanding of the nation's environments.

- The Scientific Ocean Drilling Vessel (SODV) is support for the contracting, conversion, outfitting and acceptance trials of a deep-sea drilling vessel for long-term use in a new international scientific ocean drilling program.

- Rare Symmetry Violating Processes (RSVP) consists of two major experiments that will address new physics at the cutting-edge of the sensitivity frontier and represents an extraordinary opportunity to empower a large and growing community led by university-based groups to make major discoveries.

HIGHLIGHTS OF RECENT ACCOMPLISHMENTS – TOOLS

Cosmic Snapshots: NSF-supported astronomers and instruments reported the most detailed images of the oldest light emitted by the universe -- twice. Recent results from the Cosmic Background Imager in the Chilean desert (http://www.nsf.gov/od/lpa/news/02/pr0299.htm) and from the Arcminute Cosmology Bolometer Array Receiver (ACBAR) at the South Pole (http://www.nsf.gov/od/lpa/news/02/pr0241.htm) produced high-resolution images of the cosmic microwave background (CMB) radiation. Among other results, the images map the first tentative seeds of matter and energy that later evolved into clusters of hundreds of galaxies.



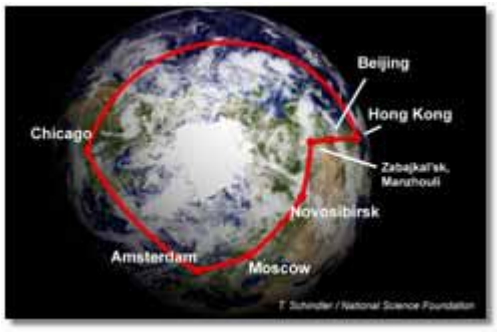
The Cosmic Background Imager consists of 13 radio antennas located on a plateau at 5,080 meters (16,700 feet) in Chile's Atacama Desert. *Credit: CBI/Caltech/NSF*

North Pole Environmental Observatory: In recent years, scientists have observed a rapid thinning of the sea ice that covers the Arctic Ocean as well as shifts in ocean circulation. These changes appear to be caused by an alteration in the atmospheric circulation of the Northern Hemisphere—known as the Arctic Oscillation—which is roughly centered at the North Pole. The Arctic Ocean circulation and the flowing of waters from the Arctic into the Greenland Sea affect the deep overturning circulation of the Atlantic Ocean and play an important role in regulating the Earth's climate. To better understand these changes and their implications for global climate, the National Science Foundation is supporting a five-year project, called the North Pole Environmental Observatory.

An oceanographic buoy deployed by Tim Stanton, of the Naval Postgraduate School, and others like it, will drift for a year in the Arctic Ocean, gathering data as part of NSF's North Pole Environmental Observatory. *Photo Credit: Peter West/NSF*

Principal Investigator James Morison, of the University of Washington, confers with a field technician about the retrieval of a deep-sea mooring at the National Science Foundation's North Pole Environmental Observatory. *Photo Credit: Peter West/NSF*

New Telescope is Born: The dream, now more than 40 years old, of constructing a radically different telescope has been realized by the innovative AMANDA-II project. Instead of sensing light, like all telescopes since the time of Galileo, AMANDA responds to a fundamental particle called a neutrino. Neutrino messengers provide a startlingly new view of the Universe. Members of the AMANDA team designed the first practical implementation of the generic ideas formulated many years ago, and re-introduced in late 80's with the twist of using Antarctic ice instead of water. Due to the remoteness of the site in Antarctica, they decided to minimize complexity of the design while recognizing that the simplest devices and system architectures were sufficient to answer the key questions. This concept proved highly effective. AMANDA is now an international collaboration involving institutions from the US, Germany, Sweden, Belgium, and Venezuela.



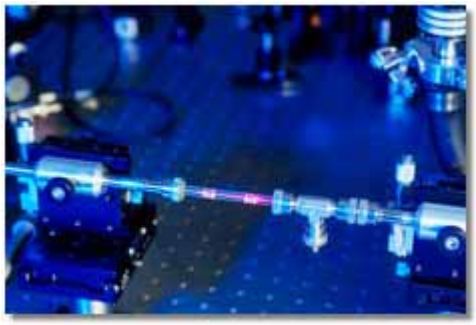
The Little GLORIAD network ring. This image shows the route of the Little GLORIAD network as it passes through Chicago, Amsterdam, Moscow, Novosibirsk, Zabajkal'sk, Manzhouli, Beijing and Hong Kong. *Credit: Trent L. Schindler/NSF*

United States, Russia, China Link Up First Global-Ring Network for Advanced Science and Education Cooperation. The National Science Foundation, a broad consortium of Russian ministries and science organizations and the Chinese Academy of Sciences have begun operations for the first round-the-world computer network ring, which will be used for joint scientific and educational projects. Known as Little GLORIAD, the ring "begins" in Chicago at the NSF-supported StarLight facility, managed by the University of Illinois at Chicago and Northwestern University. The network crosses the Atlantic Ocean to the NetherLight facility in Amsterdam from which it continues to Moscow, then to the Russian science city of Novosibirsk, across Siberia to the border at Zabajkal'sk. After crossing the border to Manzhouli, the network continues to Beijing, then Hong Kong and crosses the Pacific Ocean to complete the ring in Chicago. The new network will provide both increased reliability and flexibility for researchers as they address scientific issues including joint responses to natural and man-made disasters, safeguards for nuclear materials, better understanding of the human genome, joint exploration of space, distributed monitoring of seismic events and environmental studies and simulations. The network will also enable collaborations between universities and local schools, such as shared seminars, distance-learning programs and multi-national science fairs.

Development of a Lagrangian Balloon for Atmospheric Research. The objective of this project is to design and fly a new kind of balloon as a platform for atmospheric measurements. Atmospheric sounding by balloon-borne instruments has been practiced for nearly a century. Conventional meteorological balloons ascend relative to the air, measuring temperature, pressure, and humidity. They expand in size as they move to higher and higher altitudes, and eventually burst. Dr. Paul Voss is designing a different kind of balloon for atmospheric sounding -- one that can be controlled from the ground to reach a certain high altitude and from there on to float in equilibrium with the air around it, providing a "Lagrangian" frame of reference for measuring temperature, pressure, humidity, ozone, and other trace gases. These measurements are needed to understand the histories of air parcels as they undergo photochemical and cloud physical processes in the high atmosphere.

Wireless Network Boosts Supernova Search to Stellar First Year. Astrophysicist Greg Aldering and colleagues reported that their supernova factory project has discovered an unprecedented 34 new supernovae last year. The accomplishment would not have been possible without the National Science Foundation-supported high-performance wireless network link to Palomar Observatory. "This has been the best rookie year for any supernova search project," Aldering said. The Nearby Supernova Factory at Lawrence Berkeley National Laboratory, is seeking out 300 new exploding stars to be used as standard distance markers in future studies to measure the change in the universe's rate of expansion and thereby determine its dark energy content.

The Oschin Telescope dome at Caltech's Palomar Observatory, with adjacent HPWREN antenna. *Credit: High Performance Wireless Research and Education Network (HPWREN)*



The waveguide as it appears within the femtosecond laser amplifier system. *Image courtesy of the University of Colorado.*

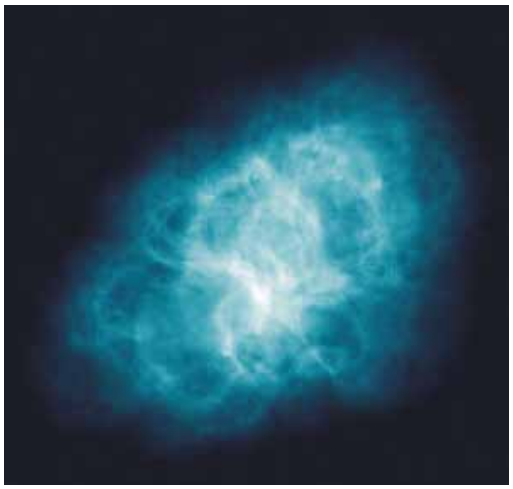
Breakthrough Brings Laser Light to New Regions of the Spectrum. Combining concepts from electromagnetic radiation research and fiber optics, researchers have created an extreme-ultraviolet, laser-like beam capable of producing tightly-focused light in a region of the electromagnetic spectrum not previously accessible to scientists. Between 10-100 times shorter than visible light waves, the extreme-ultraviolet (EUV) wavelengths will allow researchers to "see" tiny features and carve miniature patterns, with applications in such fields as microscopy, lithography and nanotechnology. The achievement is based on a new structure called a "waveguide," a hollow glass tube with internal humps that coax light waves into traveling along at the same speed and help the waves reinforce each other.

High-Performance Probes Developed at the National High Magnetic Field Laboratory. A unique capability of the NSF National High Magnetic Field Laboratory is to develop high-performance probes for nuclear magnetic resonance spectroscopy and imaging. These probes, which are used, for example, to study membrane proteins and materials chemistry under high magnetic fields, are not commercially available. Probes have been developed to support the NHMFL user programs in NMR studies of inorganic solids and for magnetic resonance imaging. More probes are in development for biological and inorganic solids. One such probe has been used to obtain spectra sensitive enough to resolve different valence states in a solid sample. Other probes used for solid-state NMR provide measurements over a wide temperature range for samples smaller than 5 mm. Still other probes have been developed for stray-field imaging. High-sensitivity cryoprobes for solution NMR experiments are in great demand, and probes are currently being developed for NMR at the highest fields available.

New South Pole Seismic Station Is One of World's Quietest and Most Sensitive.

Data collected by a new seismic observatory at the National Science Foundation's Amundsen-Scott South Pole Station indicate that it is the quietest listening post on the planet for observing shudders produced by earthquakes around the world as they vibrate through the Earth. The South Pole Remote Earth Science Observatory is located eight kilometers (five miles) from the South Pole and the new seismometers have been installed roughly 300 meters (1000 feet) beneath the surface of the continental East Antarctic ice sheet in specially drilled boreholes. The newest station in the Global Seismograph Network is now recording some of the smallest vibrations on Earth, some as much as four times smaller than could previously be recorded in the frequencies that are crucial for monitoring earthquakes both in Antarctica and globally.

South Pole Station



VLA Image of Crab Nebula

Pulsar Bursts Coming From Beachball-Sized Structures. In a major breakthrough for understanding what one of them calls "the most exotic environment in the Universe," a team of astronomers has discovered that powerful radio bursts in pulsars are generated by structures as small as a beach ball. "These are by far the smallest objects ever detected outside our solar system," said Tim Hankins, leader of the research team, which studied the pulsar at the center of the Crab Nebula, more than 6,000 light-years from Earth. "The small size of these regions is inconsistent with all but one proposed theory for how the radio emission is generated," he added. Hankins was a visiting scientist at the NSF Arecibo Observatory in Puerto Rico at the time the pulsar observations were made. Pulsars, superdense neutron stars and the remnants of massive stars that exploded as supernovae, emit powerful beams of radio waves and light. As the neutron star spins, the beam sweeps through space like the beam of a lighthouse.

Flood Damage Data Reanalysis Project. Serious floods occur in the United States every year. The President declared more than twenty US flood-related disasters in 2002 alone. Damage estimates for floods can only be considered approximate, since no one agency in the United States has specific responsibility for collecting and evaluating detailed flood loss information. The National Weather Service (NWS) is the only organization that has maintained consistent long-term historical records of flood damage throughout the country. Mary Downton, Zoe Miller, and Roger Pielke, Jr. (Center for Science and Technology Policy Research, U. Colorado) have prepared a reanalysis of NWS flood damage estimates from 1926 to 2000. Objectives of the reanalysis were to (1) assemble a national database of historical flood damage, making it as complete and consistent as possible; (2) describe what the estimates represent; (3) evaluate the accuracy and consistency of the estimates; and (4) develop guidelines for use of the data and make it widely available to users. These data sets are available on an interactive website created by

ESIG at www.flooddamagedata.org. According to NWS estimates, damage from floods caused approximately $50 billion damage in the United States during the 1990s alone.

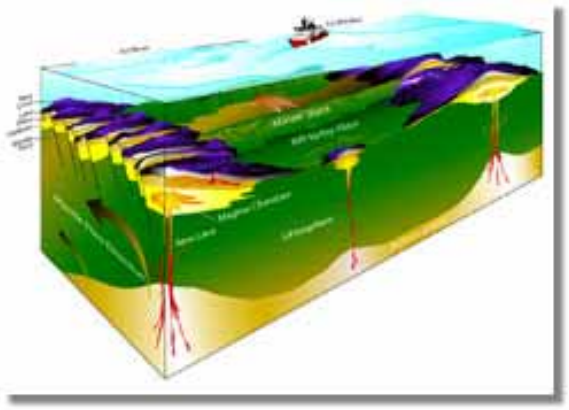
COPLINK: An Intelligent Workbench for Information Analysis and Visualization. This project initially explored different information analysis and visualization techniques for collaborative work and Web analysis using an agent approach to build personalized and collaborative tools. These techniques appeared to be both suitable and promising for applications in national security and law enforcement. Crime analysts and detectives need to analyze large sets of data to investigate criminal and terrorist activities. Software agents can monitor criminal activities and alert detectives through email, voice message, or cellular phone as soon as suspicious changes occur in databases. The ongoing COPLINK project at the University of Arizona and the Tucson Police Department can leverage these techniques in future development. The COPLINK system is designed to allow diverse police departments to share data seamlessly through simple interface, and reveals various criminal associations among police databases.

Scientists Discover Effects from Rapid, Global Climate and Ocean Changes of the Past. An international team of marine geologists has recently completed an expedition to an area off the coast of Surinam known as the Demerara Rise. The scientists were part of the NSF-supported Ocean Drilling Program (ODP) expedition in the equatorial Atlantic Ocean. The project studied periods in Earth's history that have undergone rapid climate and ocean circulation changes and likely led to mass extinctions of plants and animals.

Scientists brought up sediment cores that show other periods of dramatic change in Earth's history. In these sediments are well-preserved intervals of the Cretaceous/Tertiary boundary. At that time, some 65 million years ago, a huge asteroid or comet crashed into the Earth.

Using equipment like the drill pictured here, workers obtain geologic samples from the deep seafloor that provide scientists with new information on Earth's history. Examples of information documented by these samples include a history of the ocean basins and evidence of drastically changing climates on earth, including more ice ages than were previously known. *Photo Credit: Texas A&M*

Gakkel Ridge. The discovery that an ocean ridge under the Arctic ice cap is unexpectedly volcanically active and contains multiple hydrothermal vents may cause scientists to modify a decades-long understanding of how ocean ridges work to produce the Earth's crust. The new results, which come from a study of the Gakkel Ridge, one of the slowest spreading ridges on Earth, have broad implications for the understanding of the globe-encircling mid-ocean ridge system where melting of the underlying mantle creates the ocean floor.



This cross-section of the Gakkel Ridge as compiled by Henry Dick, co-chief scientist on the Arctic Mid-Ocean Ridge Expedition, contains a drawing of the USCGC Healy for scale. *Credit: Paul Oberlander /WHOI*

Organizational Excellence

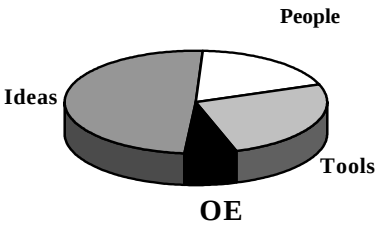
An agile, innovative organization that fulfills its mission through leadership and state-of-the-art business practices.

Summary of Organizational Excellence
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Human Capital	188.91	209.63	230.90	21.27	10.1%
Business Analysis	3.65	2.79	5.35	2.56	91.8%
Technology and Tools	46.50	60.94	112.74	51.80	85.0%
OIG	8.70	9.94	10.11	0.17	1.7%
NSB	2.88	3.88	3.95	0.07	1.8%
Total, Organizational Excellence	$250.63	$287.18	$363.05	$75.87	26.4%

Totals may not add due to rounding.

Organizational Excellence = $363.05 Million



Excellence in managing NSF's activities is an objective on par with the Foundation's mission-oriented outcome goals. It is critical for the achievement of all NSF goals. NSF's commitment to Organizational Excellence (OE) furthers its efforts under the President's Management Agenda and focuses on management challenges and reforms identified by OMB, GAO, the NSF Office of Inspector General, and through NSF's annual review of financial and administrative systems as required by the Federal Managers' Financial Integrity Act.

NSF's OE portfolio increases by 26.4 percent in FY 2005 to a total of $363.05 million, which represents 6 percent of the total NSF budget.

Organizational Excellence Long-Term Objectives: Three long-term objectives underlie NSF's Organizational Excellence goal: Human Capital, Business Processes, and Technologies and Tools.

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

Business Analysis – effective, efficient, strategically aligned business processes that integrate and capitalize on the agency's human capital and technology resources.

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

Summary of Organizational Excellence by Function
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Human Capital					
Personnel Compensation & Benefits	128.46	138.69	145.95	7.26	5.2%
IPA and Program Support (including program-related travel)	49.64	54.66	54.99	0.33	0.6%
Management of Human Capital	2.69	3.55	15.70	12.15	342.3%
Operating Expenses	3.80	6.68	7.00	0.32	4.8%
Travel	4.32	6.05	7.26	1.21	20.0%
Subtotal, Human Capital	188.91	209.63	230.90	21.27	10.1%
Business Analysis	3.65	2.79	5.35	2.56	91.8%
Technology and Tools					
Information Technology	24.36	37.18	84.29	47.11	126.7%
Space Rental	17.10	18.20	19.30	1.10	6.0%
Other Infrastructure	5.04	5.56	9.15	3.59	64.6%
Subtotal, Technology and Tools	$46.50	$60.94	$112.74	51.80	85.0%
Office of the Inspector General	8.70	9.94	10.11	0.17	1.7%
Office of the National Science Board	2.88	3.88	3.95	0.07	1.8%
Total, Organizational Excellence	$250.63	$287.18	$363.05	75.87	26.4%

Totals may not add due to rounding.

NSF Workforce
(Full-Time Equivalents (FTE))

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
NSF S&E -- Regular	1,146	1,200	1,225	25	2.1%
NSF S&E -- Student	32	24	24	0	0.0%
Office of the Inspector General[1]	55	60	60	0	0.0%
National Science Board[2]	9	12	12	0	0.0%
Arctic Research Commission[3]	4	4	4	0	0.0%
Subtotal, FTE	1,246	1,300	1,325	25	1.9%
IPA[4]	142	170	170	0	0.0%
Detailees to NSF	6	5	5	0	0.0%
Contractors Performing Admn. Functions	191	210	210	0	0.0%
Total, Workforce	1,585	1,685	1,710	25	1.5%

[1]The Office of Inspector General is described in a separate section of the justification and is funded through a separate appropriation.
[2]The National Science Board is described in a separate section of the justification and is funded through a separate appropriation.
[3]The Arctic Research Commission is described and funded in the Research and Related Activities section of the justification under Polar Programs.
[4]Intergovernmental Personnel Act (IPAs) are described in the Organizational Excellence section and are funded through the Research and Related Activities and Education Human Resources Appropriations accounts.

FY 2005 Annual Performance Goal for Organizational Excellence: NSF will demonstrate significant achievement for the majority of the following performance indicators related to the *Organizational Excellence* outcome goal:

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

Comparison to FY 2004 Goal: This is a new performance goal for FY 2005 that will also be evaluated for FY 2004. It was developed based on the updated NSF Strategic Plan FY 2003 through FY 2008.

Means and Strategies for Success:

The means and strategies NSF uses to successfully achieve Organizational Excellence include:

- Support for the NSF Academy. Enabling the future of NSF by inspiring a culture of learning, the NSF Academy is committed to ensuring the highest level of achievement for all NSF staff by providing continuous learning opportunities through a variety of educational venues in support of the agency's mission. The Academy will expand in the areas of e-business courses, NSF's blended learning portfolio, new employee orientation and career development activities.

- External input through the Business and Operations Advisory Committee. The committee includes leading officials in research administration, education management, information technology, and public administration. The Committee is charged with providing advice on issues related to NSF's business practices and operations, including innovative approaches to the achievement of NSF's strategic goals.

- Evaluation through the Advisory Committee for GPRA Performance Assessment. NSF determined that a more efficient and effective process for the assessment of agency performance with respect to strategic goals was to charge a single external committee of experts with review of all Foundation accomplishments. The Committee is comprised of about 18-25 independent external experts representing academia, industry, and government.

- Findings and Recommendations from the NSF Business Analysis. The Business Analysis is central to NSF's overall framework for long-term investments in OE. The analysis focuses on how NSF can best respond to such challenges as managing a portfolio that is growing in both size and complexity and becoming a fully integrated organization capable of working both within and across boundaries – be they disciplinary, sectoral, institutional, or international. The analysis also addresses key underlying issues raised in the President's Management Agenda and to government-wide issues identified by the Government Accounting Office.

- Implementation of the new Strategic Human Capital Initiatives. These initiatives include recruitment, outreach, and accountability.

- Employment of next-generation technology. NSF is continuing to re-engineer internal processes to implement technology-enabled solutions for the future.

- Improved monitoring and oversight through increased funding for travel. These capabilities include additional management and oversight activities, such as site visits to major facilities, as well as increased outreach, participation in science and engineering workshops, and staff training.

Resources Required: This goal can be achieved with NSF's requested FY 2005 staff and budgetary resources, as outlined later in this chapter.

FY 2005 Annual Performance Goal – Time to Decision: For 70 percent of proposals, be able to inform applicants whether their proposals have been declined or recommended for funding within six months of deadline or target date, or receipt date, whichever is later.

Percent proposals processed within 6 mos of deadline/target date, or receipt date, whichever is later									
FY:	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Baseline	61%								
Goal			70%	70%	70%	70%	70%	70%	70%
Result		59%	58%	54%	62%	74%	77%	&	&

Means and Strategies for Success (Time to Decision):

- NSF initiated a series of staff brainstorming sessions on "time to decision" in order to identify effective practices related to timely processing of proposals. The results of these sessions have been widely disseminated throughout NSF.
- "Real-time" management reports to help staff pinpoint pending proposals in danger of exceeding the six-month processing goal were developed and are distributed monthly to NSF senior management.
- Some divisions have added "performance on prompt handling of proposals" to their performance evaluation criteria for Program Officers.
- Managers and staff throughout the Foundation are being recognized for efforts to improve timely processing of proposals and thereby reduce the time to decision.

NSF celebrates achieving the "time to decision" goal in FY 2002. Dr. Colwell is pictured here presenting an award to NSF staff.

- NSF staff continue to work towards shortening the award process time by making more effective use of electronic mechanisms in conducting reviews, working cooperatively to eliminate overloads and bottlenecks, and carefully tracking the stage of processing and age of all proposals.

Resources Required (Time to Decision): This goal can be achieved with NSF's requested FY 2005 staff and budgetary resources.

FY 2005 Investments in Organizational Excellence

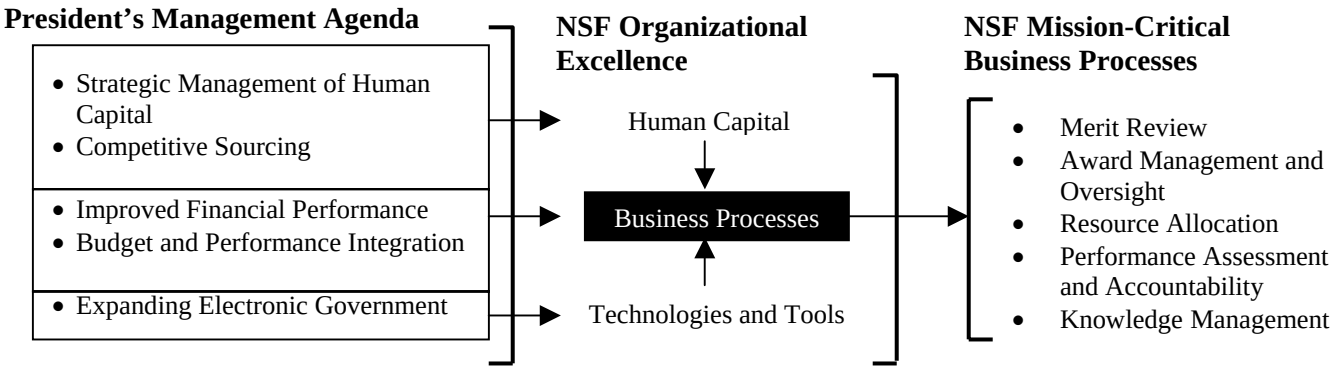
Organizational Excellence (OE) is NSF's top investment priority for FY 2005. This will enable NSF to address the mounting pressures on staff and infrastructure brought on by the increased workload and the increasing complexity of the workload.

The National Science Foundation's commitment to OE parallels its leadership in advancing the frontiers of science and engineering research and education. The agency has a solid history of leveraging its agile, motivated workforce, mission-essential management processes, and state-of-the-art technological

resources to promote the progress of science and engineering through investments in People, Ideas, Tools, and Organizational Excellence.

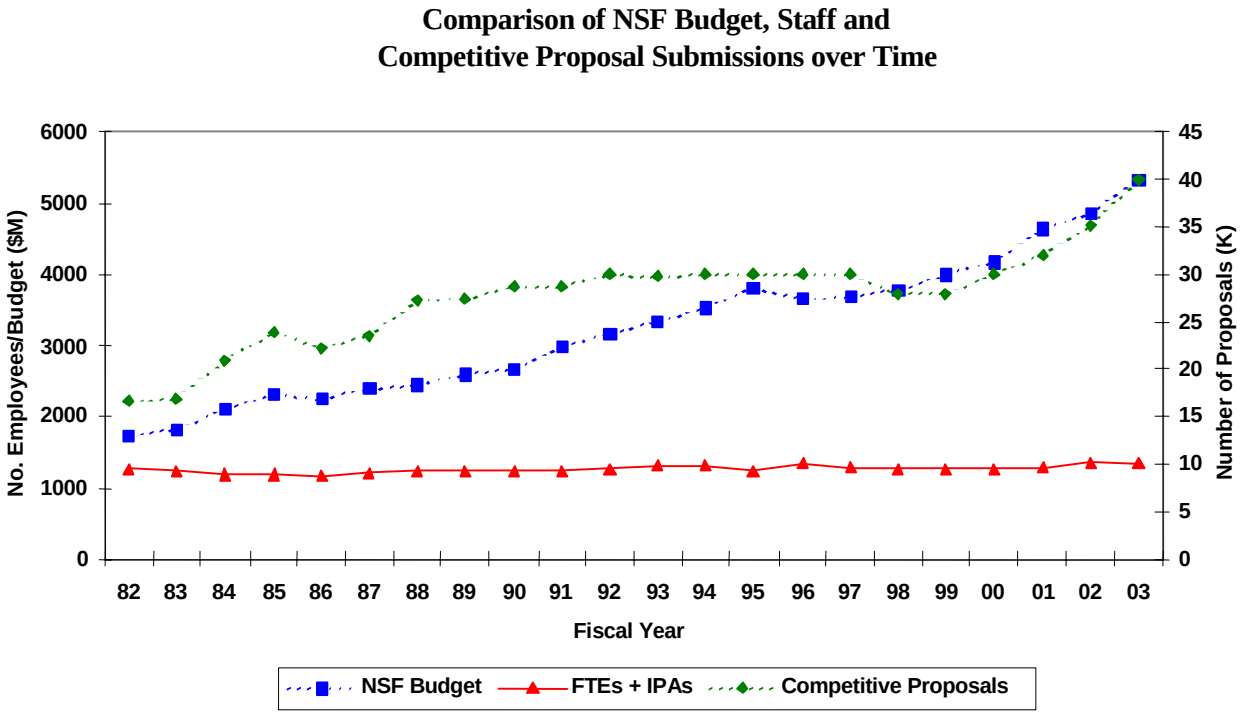
NSF's ongoing emphasis on Organizational Excellence relates directly to the President's Management Agenda (PMA), as illustrated below.

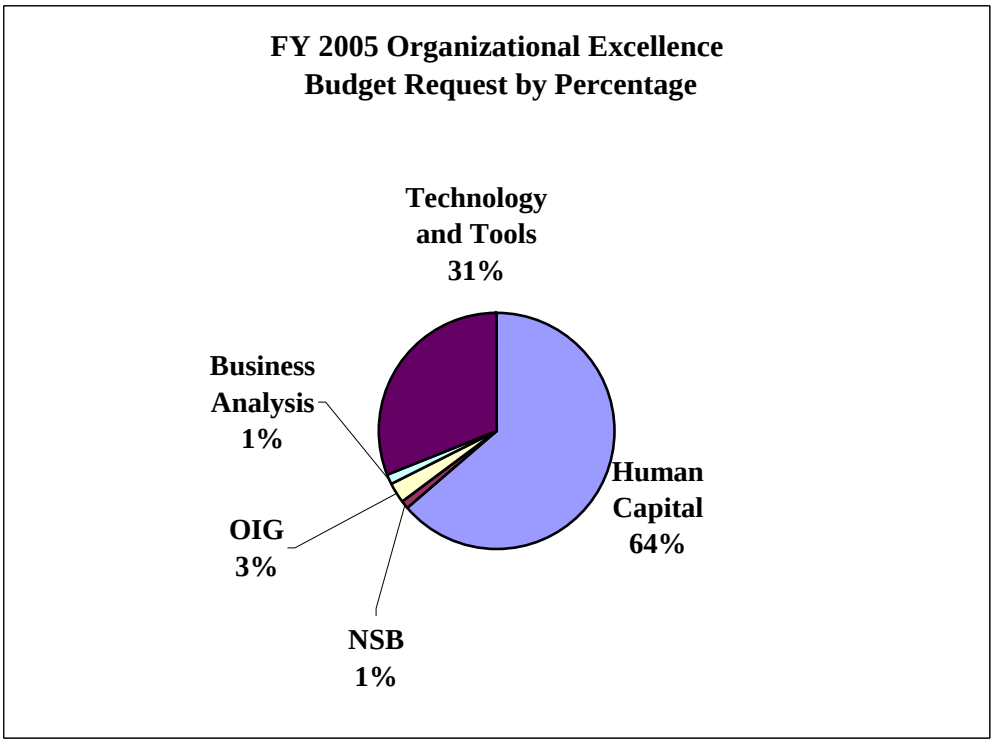
Relationship of PMA, NSF's Strategic Plan, and NSF Mission-Critical Business Processes



The FY 2005 request for Organizational Excellence is based on the framework established in the updated NSF Strategic Plan. **Human Capital** and **Technology and Tools** represent the two principal investment thrusts, which in turn enable NSF's **Business Processes.**

NSF began placing special emphasis on increasing funding for OE in FY 2003. As is shown in the graph below, over the last two decades, the number of proposals has doubled and the budget has tripled in constant dollars, while the staff has remained essentially level. It is essential to maintain this focus in FY 2005 and beyond in order to adequately provide the agency with resources needed to operate effectively.


Comparison of NSF Budget, Staff and
Competitive Proposal Submissions over Time
No. Employees/Budget ($M)
Number of Proposals (K)
6000
5000
4000
3000
2000
1000
0
45
40
35
30
25
20
15
10
5
0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03
Fiscal Year
NSF Budget
FTEs + IPAs
Competitive Proposals


FY 2005 Organizational Excellence
Budget Request by Percentage
Technology
and Tools
31%
Business
Analysis
1%
Human
Capital
64%
OIG
3%
NSB
1%

The Organizational Excellence Portfolio

The Foundation's Organizational Excellence activities are funded through five appropriations:

- **Salaries and Expenses** (S&E) increases by $75.30 million, or 34.4 percent, to $294.0 million in FY 2005. These resources include funding for personnel compensation and benefits, administrative travel, training, rent, IT-enabled business systems, administrative contractual services, supplies, equipment, and other operating expenses necessary for effective management of NSF's research and education activities.
- **Office of Inspector General** (OIG) increases by $170,000, or 1.7 percent, to $10.11 million in FY 2005. These resources include funding for personnel compensation and benefits, contract audits, training and operational travel, office supplies, materials, and equipment.
- **Office of the National Science Board** (NSB) increases by $70,000, or 1.8 percent, to $3.95 million in FY 2005. These resources include funding for personnel compensation and benefits, contract, training and operational travel, office supplies, materials, and equipment.
- Support costs funded in the **Program Accounts - Research and Related Activities** (R&RA) and **Education and Human Resources** (EHR) - increase by $330,000 to $54.99 million in FY 2005. These costs include funding for personnel appointments under the Intergovernmental Personnel Act (IPAs), administrative contracts, and requisitions that directly support programs. Support costs also include funding for Foundation-wide evaluation contracts of NSF priority area investments and other strategically significant programs.

Organizational Excellence by Appropriations
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Salaries and Expenses	194.45	224.70	300.00	75.30	33.5%
Less Reimbursements[1]	5.03	6.00	6.00	0.00	0.0%
Subtotal	189.42	218.70	294.00	75.30	34.4%
Office of Inspector General					
Appropriation	8.70	9.94	10.11	0.17	1.7%
Financial Statement Audit[2]	[0.83]	[0.80]	[0.81]	[0.01]	[1.25]
Office of the National Science Board	2.88	3.88	3.95	0.07	1.8%
Administrative Activities funded in					
R&RA Appropriation	37.55	39.29	41.62	2.33	5.9%
EHR Appropriation[3]	12.09	15.37	13.37	-2.00	-13.0%
Total	$250.63	$287.18	$363.05	$75.87	26.4%

Totals may not add due to rounding.

[1]NSF enters into agreements (including Memoranda of Understanding) with other U.S. government agencies, as authorized by the NSF Act, 42 U.S.C. 1870 (c) and the Economy Act: 31 U.S.C. 1535, under which NSF assumes some responsibility for activities supported by these agencies. Reimbursements in the Salaries and Expenses Account are realized from administrative cost recoveries that are associated with these interagency agreements.

[2]Non-add funded from R&RA and EHR Appropriations and included in those estimates.

[3]Excludes OE expenses for H-1B Nonimmigrant Petitioner Receipts.

HIGHLIGHTS OF RECENT ACCOMPLISHMENTS - ORGANIZATIONAL EXCELLENCE

- NSF's "Evaluation Culture" Highlighted by the General Accounting Office (GAO). NSF's commitment to Organizational Excellence is greatly enhanced by the agency's tradition of seeking external advice and guidance. Two committees in particular - the Advisory Committee for Business and Operations and the Advisory Committee for GPRA Performance Assessment - have integral roles in areas related to OE, notably electronic government, human capital management, business processes, and assessment and evaluation. This tradition of routinely seeking outside advice and input was highlighted in the May 2003 GAO report, *Program Evaluation: An Evaluation Culture and Collaborative Partnerships Help Build Agency Capacity.* GAO found that the NSF was one of five Federal agencies that foster an "evaluation culture - a commitment to self-examination, data quality, analytic expertise, and collaborative partnerships."

- NSF's exemplary performance was highlighted by receipt of the President's 2003 Award for Management Excellence for the Foundation's innovative electronic capabilities to solicit, receive, review, select, award, manage and report results on public research and education investments. The award recognizes NSF's successful FastLane system, an interactive, real-time, web-based system used by over 200,000 scientists, educators, technology experts and administrators, including the country's top researchers, to conduct business over the Internet. The award further recognizes NSF's leadership role in the Federal eGovernment initiatives that directly relate to NSF's science and engineering, research and education mission as well as supporting initiatives that affect all Federal agencies.

- Final Highlight - NSF continues to strive towards improving its systems to better serve the community. For example, in FY 2003 NSF improved its policies and systems to make it easier for researchers from all types of institutions to collaborate on research projects. In large part because of the improvements, NSF projects the number of projects that utilize researchers from multiple institutions to double by the end of fiscal year 2005.