NSF INVESTMENTS AND STRATEGIC GOALS

NSF Investments and Strategic Goals

The National Science Foundation's FY 2004 funding request supports the agency's investment in *People*, *Ideas*, and *Tools* – the Foundation's three 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. 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 administration and management.

- *People* - Developing "a diverse, internationally competitive and globally engaged workforce of scientists, engineers and well-prepared citizens."
- *Ideas* - Enabling "discovery across the frontier of science and engineering, connected to learning, innovation, and service to society."
- *Tools* - Providing "broadly accessible, state-of-the-art and shared research and education tools."

NSF Budget by Strategic Goal
(Dollars in Millions)

	FY 2002	FY 2003	FY 2004	Change	
	Actual	Estimate	Estimate	Amount	Percent
People	995	1,087	1,153	66	6.1%
Ideas	2,436	2,559	2,696	137	5.3%
Tools	1,112	1,122	1,341	219	19.6%
Administration and Management	231	261	291	31	11.8%
Total, NSF[1]	$4,774	$5,028	$5,481	$453	9.0%

Totals may not add due to rounding.
[1]Total does not include $57.31 million in FY 2002, an estimate of $65.68 million in FY 2003 from H-1B Nonimmigrant Petitioner Fees. Legislation for this activity expires in FY 2003.

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:

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

Additionally, in FY 2004, NSF resources will support the Administration's six interagency research and development (R&D) investment priorities: Networking and Information Technology Research and Development; National Nanotechnology Initiative; Molecular-level Understanding of Life Processes;

Climate Change and Science and Technology; Education Research; and Homeland Security and Antiterrorism. NSF will support development of these important priorities.

Detailed discussions of NSF's investment in *People*, *Ideas*, *Tools*, and Administration and Management follow this section on core and priority area research.

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 vital role in providing this balance for U.S. science and engineering. This budget request also boosts NSF's investment in the physical sciences.

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 2004 Request emphasizes investments in six interdependent priority areas – Biocomplexity in the Environment; Information Technology Research; Nanoscale Science and Engineering; Mathematical Sciences; Human and Social Dynamics; and Workforce for the 21st Century. In addition, NSF continues to give highest priority to the Math and Science Partnership begun in FY 2002 as part of the President's education plan *No Child Left Behind*. 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 as, for example, concepts and techniques from the mathematical sciences 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 2002 Actual	FY 2003 Request	FY 2004 Request	Change Amount	Change Percent
Biocomplexity in the Environment	58.96	79.20	99.83	20.63	26.0%
Information Technology Research	277.22	285.83	302.61	16.78	5.9%
Nanoscale Science and Engineering	204.48	221.25	248.99	27.74	12.5%
Mathematical Sciences	30.00	60.09	89.09	29.00	48.3%
Human and Social Dynamics	N/A	10.00	24.25	14.25	142.5%
Workforce for the 21st Century	N/A	N/A	8.50	8.50	N/A
Total, Priority Areas	$570.66	$656.37	$773.27	$116.90	17.8%

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 climate 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, and environmental and human health 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 behavior. Advanced computational strategies and technologies must be developed and utilized. The term "biocomplexity" is used to stress the requirement that research questions must explicitly address the dynamic web of interrelationships that arise when living things at all levels – from molecular structures to genes to organisms to urban centers to ecosystems – 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.

Biocomplexity in the Environment Funding
(Dollars in Millions)

	FY 2002 Actual	FY 2003 Request	FY 2004 Request	Change Amount	Change Percent
Biological Sciences	16.90	35.86	39.86	4.00	11.2%
Computer and Information Science and Engineering	6.10	7.36	8.00	0.64	8.7%
Engineering	3.60	6.00	6.00	0.00	0.0%
Geosciences	23.00	22.22	37.22	15.00	67.5%
Mathematical and Physical Sciences	4.95	4.70	4.70	0.00	0.0%
Social, Behavioral and Economic Sciences	3.00	1.65	2.50	0.85	51.5%
Office of Polar Programs	1.41	1.41	1.55	0.14	9.9%
Total, Biocomplexity in the Environment	$58.96	$79.20	$99.83	$20.63	26.0%

Totals may not add due to rounding.

Long-term Goals: For the next two years, NSF will emphasize research and education on the role of Biocomplexity in the Environment. This priority area is part of investments and accomplishments within NSF's FY 2004 environmental investment portfolio of approximately $960 million. The intellectual goals of the effort are to:

- Synthesize environmental knowledge across disciplines, subsystems, time and space;
- Discover new methods, 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 other human behaviors that affect the environment; 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 Request	FY 2004 Request	FY 2005
$50.00	$54.88	$58.96	$79.20	$99.83	$101.83

FY 2004 Areas of Emphasis: In FY 2004, 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** – a systematic effort to use high throughput sequencing to determine the genetic composition and gene function 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 forecasting their response to environmental changes.

- **Ecology of Infectious Disease** – development of predictive models and discovery of principles for relationships between environmental factors and transmission of infectious agents. Research focuses on ecological determinants of disease transmission, unintended health effects of environmental change, and improved prediction of disease outbreaks, emergence, and reemergence. Examples of environmental factors include habitat transformation, invasive species, biodiversity loss, climate change, toxic pollution, and bioterrorism.

- **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:

- Molecular scale studies of environmental processes and technologies – interdisciplinary teams to investigate biogeochemical processes, benign materials development, and alternative manufacturing processes at the level of molecular reactions and interfaces.
- Water cycle and freshwater resources – fundamental research across the full dimension of the water cycle, with emphasis on understanding fluxes of water among hydrologic reservoirs, causes and prediction of water cycle variability, and linkages between the water cycle and geochemical constituents.
- Carbon cycle and geomicrobiology – research on the chemical, biological, ecological, and physical processes driving carbon distribution, transformation and transport within and between terrestrial, atmospheric, and oceanic environments.
- Social and behavioral processes – emphasis on predictive capabilities and response to extreme and unpredictable events, including the study of adaptation to environmental change in the Arctic.
- "Tree of Life" – a cross-disciplinary exploration of genealogical relationships of the 1.7 million named extant species using new algorithmic methods and genomic technologies, with the goal of constructing a universal genealogy for a wide range of uses in medicine, technology, agriculture and industry.
- Educational activities – a range of projects associated with biocomplexity studies that include informal science activities, professional growth of science teachers, development of instructional material, and efforts in scientific literacy and communication.
- International partnerships – collaborations that include research partners in other countries in order to broaden the experience of U.S. students and expand the scope of biocomplexity research activities.

Information Technology Research

Information Technology (IT) today 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 supports research that extends the frontiers of IT, improves our understanding of IT and its impacts on society, and helps prepare Americans for the Information Age. 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 continues 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 will continue to exploit and deepen the ongoing research and will continue 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. The program will continue 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.

Information Technology Research Funding
(Dollars in Millions)

	FY 2002 Actual	FY 2003 Request	FY 2004 Request	Change Amount	Change Percent
Biological Sciences	6.08	6.80	7.50	0.70	10.3%
Computer and Information Science and Engineering	173.51	190.67	218.11	27.44	14.4%
Engineering	10.23	11.17	11.17	0.00	0.0%
Geosciences	12.16	13.21	14.56	1.35	10.2%
Mathematical and Physical Sciences	32.66	35.52	35.04	-0.48	-1.4%
Social, Behavioral and Economic Sciences	4.36	4.65	5.15	0.50	10.8%
Office of Polar Programs	1.22	1.33	1.55	0.22	16.5%
Subtotal, Research and Related Activities	240.22	263.35	293.08	29.73	11.3%
Education and Human Resources	2.00	2.48	9.53	7.05	284.3%
Subtotal, R&RA and Education and Human Resources	242.22	265.83	302.61	36.78	13.8%
Major Research Equipment and Facilities Construction	35.00	20.00	0.00	-20.00	-100.0%
Total, Information Technology Research	$277.22	$285.83	$302.61	$16.78	5.9%

Totals may not add due to rounding.

Long-term Goals: By expanding basic research in interdisciplinary areas, with a strong emphasis on interdisciplinary opportunities, NSF will amplify the benefits of IT in all areas of science and engineering, stimulate broad research on the fundamental challenges facing the expansion of IT and spur progress across the national economy and society. The Information Technology Research program will involve seven comprehensive and complementary areas of emphasis described below.

Long-term Funding for Information Technology Research
(Dollars in Millions)

FY 2000 Actual	FY 2001 Actual	FY 2002 Actual	FY 2003 Request	FY 2004 Request
$126.00	$261.17	$277.22	$285.83	$302.61

FY 2004 Areas of Emphasis: Investments will emphasize the following research:

- **Large-Scale Networking**. Research in large-scale networking will focus on fundamental research in optical networking, simulation of network dynamics, fault tolerance and autonomous management of network resources, wireless networks, and scalability to improve performance and handling of transient interactions among billions of networked devices and controlling sensors. Additional research in large-scale networking will focus on new and revolutionary paradigms to ensure user privacy, increase security of sensitive information, and enhance the protection of our critical infrastructures. Research will lead to ultra-large scale networks that are secure, stable, reliable, resistant to failures and resilient to extreme events. These higher levels of reliability and stability will contribute, for example, to next-generation air traffic control systems or to telemedicine's potential for remote monitoring, diagnosis, and care for homebound and isolated citizens.

- **High-Confidence Software and Systems**. Research in this area will support a new generation of highly reliable and trustworthy IT systems, including safe, secure, and dependable information infrastructures and consumer products for an information society. It will provide a sound theoretical, scientific, and technological basis for assured construction and certification of safe, trusted computing systems in interconnected environments. The priority area will support research that will advance our understanding of how to build system engineering tools that incorporate risk-based assurance appropriate to specific domains, and research that will lead to scientific principles for the construction of high-confidence systems that are predictable and robust, including adaptive, self-healing systems that are able to function after attack or system failure. Additionally, research will support new paradigms, tools and methods for modeling and enforcing stability of software systems and the actual systems they control from safety-critical automotive and avionics systems, to implantable devices and advanced prosthetics.

- **Human-Computer Interaction and Information Management**. Research will focus on advanced understanding of the needs of end users in work and learning environments, and tools and technologies for organizing, annotating, searching, mining, visualizing, preserving, and utilizing distributed, heterogeneous, multimedia archives and large database systems. The program will also support research that seeks to enhance, through IT, human abilities, investigate language technologies, augment our understanding of how to integrate perception, cognition, and computation, and develop innovative cognitive interfaces and multi-modal technologies, tools and devices. The research investments will lead to improved real-time access to databases, which in turn will accelerate progress and aid in policy-making. Interactions between medicine, robotics, and networking offer the hope of designing robotic assistants for the elderly and disabled.

- **Software Design and Productivity**. Research will focus on developing theory and technology for large embedded software applications subject to temporal, noise, synchronization and dependability constraints. The key technology components to be developed are integrated modeling techniques, integrated modeling environments and model-based generators. Research investments in this priority area will support the development of mathematical, computer science, and engineering models to test new directions for cost-effective development of very high-quality software in the emerging world of

interconnectivity among heterogeneous devices, from embedded processors to mobile devices to massive systems of systems. The program will invest in research that seeks to enhance our understanding of scalability and the inherent heterogeneity of components, achieve improvements by evaluating and testing the practical applicability of new methods and techniques on realistic large-scale application platforms, and address the theoretical foundations of software design while including substantial experimental evaluations.

- **Social, Economic and Workforce Implications of IT and IT Workforce Development**. Research investments in this category will support issues about the manner in which social, behavioral, economic, and political process shape the use of IT by people, organizations, and cultural groups, as well as the ways IT affects economic growth, democracy and political processes. Innovative information technology applications will be developed for work-related learning, including improved uses of existing and emerging information technologies to transform the way our workforce learns, increase the universal participation in a digital society by women, minorities and underrepresented groups and promote the use and development of new learning methods and interactive learning environments of an effective integration of IT with education and training.

- **High-end Computing**. Research in High-end Computing will continue to focus on advanced computing concepts targeted at scientific and engineering applications, including innovative and non-conventional architectures, software technologies, and algorithms. Advances in photonics, nanodevices, sensors, actuators, opto-electronics, and smart fabrics make it possible to provide extremely fast and high-density processing power. The program will seek to explore new computational substrates, such as quantum or DNA computing, and investigate new materials and methods to create wholly new designs for processors in computing devices. Additionally, investments in this priority area will support research on the design of new, modular hybrid architectures that will enable high-degrees of fault-tolerance, programmability and security features needed in embedded systems. All of these hardware technologies and software components must be integrated seamlessly and reliably in large-scale, parallel and distributed systems.

- **High-end Computation and Infrastructure**. Research in this priority area will continue to provide support for terascale computing and computational facilities needed for high-end computational capabilities and promote collaborative research and information sharing across the sciences. The research will build on current scientific knowledge of human perception, cognition, communication and physical response to enable unprecedented opportunities for new information technologies which will amplify human physical, mental and sensory abilities, and enhance the performance and experiences of human beings in a variety of activities, occupations, and social contexts. Investments in this category will also support research in protein folding, neural modeling, and gene expression. This category will also focus on research which seeks to gain new insights into the interactions between biological and physical components of ecosystems and pollutants, atmosphere, oceans and soil, and which can lead to the development of new models and new methods of data management. Additionally, the priority area will support research on meteorological forecasting, modeling of earthquakes, oceanographic computations linked to biological studies of ocean productivity and biodiversity, and high-end computing tools to accelerate the design and implementation of next generation manufacturing techniques such as photonic crystals, optical and electronic switching devices, sensors and detectors.

Nanoscale Science and Engineering

Nanoscale science and engineering 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 oil industry, and order of magnitude faster computer chips.

Nanoscale science and engineering 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 2002 Actual	FY 2003 Request	FY 2004 Request	Change Amount	Change Percent
Biological Sciences	2.50	2.98	4.98	2.00	67.1%
Computer and Information Science and Engineering	10.20	11.14	15.14	4.00	35.9%
Engineering	86.30	94.35	106.85	12.50	13.2%
Geosciences	6.80	7.53	7.88	0.35	4.6%
Mathematical and Physical Sciences	98.68	103.92	110.42	6.50	6.3%
Social, Behavioral and Economic Sciences	0.00	1.11	1.50	0.39	35.1%
Subtotal, Research and Related Activities	204.48	221.03	246.77	25.74	11.6%
Education and Human Resources	0.00	0.22	2.22	2.00	909.1%
Total, Nanoscale Science and Engineering	$204.48	$221.25	$248.99	$27.74	12.5%

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, including shared user facilities; supporting research infrastructure; 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 2003, NSF requested $221.25 million for research in a wide range of research and education activities in this priority area, including approximately 15 nanotechnology research and education centers, which focus on electronics, biology, optoelectronics, advanced materials and engineering.

This investment will be expanded in FY 2004 to develop and strengthen critical fields (including nanobiotechnology, manufacturing at the nanoscale, instrumentation, and education) to establish the science and engineering infrastructure and workforce needed to exploit the opportunities presented by these new capabilities. In addition to single investigator research, support will be focused on 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 will have access to a full range of nano-facilities; enabling access to nanotechnology education for students in U.S. 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 improvements in health, advance agriculture, conserve materials and energy, and sustain the environment.

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

FY 2001 Actual	FY 2002 Actual	FY 2003 Request	FY 2004 Request	FY 2005
$149.68	$192.28	$221.25	$248.99	$253.97

These increases are needed to bring funding up to the levels suggested by National Science Technology Council/Office of Science Technology Policy (NSTC/OSTP) or recommended by the National Research Council report on NNI.

FY 2004 Areas of Emphasis: NSF's planned investment for Nanoscale Science and Engineering in FY 2004 is $248.99 million. NSF five programmatic focus areas are:

- **Fundamental Research and Education.** The FY 2004 request includes $152 million for fundamental research and education, with special emphasis on:
  - *Biosystems at the Nanoscale* – Approximately $21 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 $57 million to discover and understand phenomena specific at the nanoscale, 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 $28 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 $10 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 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 $11 million to support new concepts for high rate synthesis and processing of nanostructures, 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 $3 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 $10 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 $46 million will support four new research and education centers initiated in FY 2002, and a multidisciplinary, multi-sectoral network for modeling and simulation at the nanoscale.

- **Research Infrastructure.** Approximately $28 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 expensive instrumentation and facilities. A National Nanofabrication Infrastructure Network (NNIN) will be established.

- **Societal and Educational Implications of Science and Technology Advances.** Approximately $13 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.

In 2004, the Nanoscale Science and Engineering priority area will continue its focus on fundamental research through investments in investigator-led activities, centers and networks of excellence, and infrastructure. Transition from scientific discoveries to technological innovation is likely to increase due to the increased rate of discoveries in the last couple of years. Priority in funding will be given to: (1) research to enable the nanoscale as the most efficient manufacturing domain, (2) nanobiotechnology, and nanobiology for improving human performance, (3) innovative nanotechnology solutions to biological-chemical-radiological-explosive detection and protection, (4) the discovery, understanding and potential application of phenomena specific to the nanoscale, (5) development of new instrumentation and standards, (6) the education and training of the new generation of workers for future industries, and (7) establishing of the National Nanotechnology Infrastructure Network (NNIN) for user facilities, development of new instrumentation, and training.

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 which 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 resources devoted to three key areas – fundamental mathematical and statistical research, interdisciplinary collaboration between the mathematical sciences and other disciplines, and mathematics education – have not kept pace with the needs, thus limiting the nation's scientific, technical, and commercial enterprises. To strengthen the mathematical foundations of science and society, the NSF will expand the priority area, focused in 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 2002	FY 2003	FY 2004	Change	
	Actual	Request	Request	Amount	Percent
Biological Sciences		0.91	2.21	1.30	142.9%
Computer and Information Science and Engineering		2.29	2.29	0.00	0.0%
Engineering		0.91	2.91	2.00	219.8%
Geosciences		4.57	7.07	2.50	54.7%
Mathematical and Physical Sciences	30.00	47.39	70.19	22.80	48.1%
Social, Behavioral and Economic Sciences		1.10	1.50	0.40	36.4%
Office of Polar Programs		0.18	0.18	0.00	0.0%
Subtotal, Research and Related Activities	$30.00	$57.35	$86.35	29.00	50.6%
Education and Human Resources	$0.00	$2.74	$2.74	0.00	0.0%
Total, Mathematical Sciences	$30.00	$60.09	$89.09	29.00	48.3%

Totals may not add due to rounding.

Long-term Goals: From FY 2003 through FY 2007, NSF will emphasize research and education in the mathematical sciences. 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 focused on selected themes, and (3) critical investments in mathematical sciences education. The five-year investment plan 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 Mathematical Sciences

(Dollars in Millions)

FY 2002 Actual	FY 2003 Request	FY 2004 Request	FY 2005	FY 2006	FY 2007	FY 2008
$30.00	$60.09	$89.09	$90.87	$92.69	$94.54	$96.43

FY 2004 Areas of Emphasis: NSF plans to invest $89.09 million in the Mathematical Sciences activities described below. These investments fall into three primary areas: (1) fundamental mathematical and statistical sciences, (2) interdisciplinary research connecting the mathematical sciences with science and engineering, and (3) mathematical sciences education.

- **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, Bayesian estimation, and multi-scale and multi-resolution analysis. To enhance research in these areas, NSF will provide improved support for mathematical sciences through focused research groups and individual investigator grants, as well as through institutional 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, research themes have been identified for initial emphasis 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 helping to forecast 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 and engineering, 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.

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 focused 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.

- **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: teacher preparation and professional development; curriculum development both in the mathematical sciences and in incorporating sophisticated mathematics into other disciplines; introducing new technologies and materials 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.

Human and Social Dynamics

The arrival of the twenty-first century has brought with it new hopes and possibilities for better living but also change, uncertainty, and disruption. The tragedy of September 11, 2001 shattered our nation's sense of security. Economic fluctuations have shaken faith in the new economy. Advances in biotechnology have brought with them the promise of postponing aging and conquering disease, but they have also forced us to reconsider basic questions about the nature of life and the ethical parameters for research. Computing and communications technologies have created a wealth of new employment opportunities and transformed many jobs so as to increase productivity, but they have also rendered large numbers of once vibrant jobs obsolete. Workplace rewards for education have increased dramatically, yet the country's educational system is not producing a workforce with the science, mathematics and technology skills needed to retain its leadership in the global marketplace.

Social and knowledge systems do not develop independently. Humans develop new knowledge that leads to new technologies. Social institutions shape what is produced and determine how these new products become part of everyday life. 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 continued progress. Multi-scaled, multidisciplinary approaches, many of which have been made possible by recently acquired knowledge and new technologies, can yield this understanding. A new NSF priority area, *Human and Social Dynamics*, will develop and apply these approaches.

This priority area seeks to better understand the causes and ramifications of change, to increase our collective ability to anticipate the complex consequences of change (cultural, science and technology, economic, individual, political, and social), to better understand the dynamics of the human mind, to better understand the cognitive and social structures that create and define change, and to help people and organizations better manage profound or rapid change.

Understanding human and social dynamics in a changing world requires us to examine past and ongoing large-scale social changes from a variety of perspectives, paying special attention to the reciprocal relationship between individual and social action, on the one hand, and knowledge production and technological change, on the other. We must also investigate how human cognition and social forces work together to shape attitudes toward change. Understanding the role of human cognition involves exploring the relationship between genetic and social factors in cognition, considering human emotions as forces that both shape and respond to change, and unraveling the long-term evolution of the cognitive strengths and limitations that shape human existence. Understanding the influence of social and economic forces requires attention to gender, race and culture as well as to social institutions like markets, government and the media. This priority area also requires research into smaller scale institutions such as firms, voluntary associations, and police forces. We must also pay attention to the implications of social dynamics for diversity and equality.

Human and Social Dynamics Funding
(Dollars in Millions)

	FY 2002 Actual	FY 2003 Request	FY 2004 Request	Change Amount	Change Percent
Biological Sciences			0.50	0.50	N/A
Computer and Information Science and Engineering			3.00	3.00	N/A
Engineering			2.00	2.00	N/A
Geosciences			1.35	1.35	N/A
Mathematical and Physical Sciences			0.50	0.50	N/A
Social, Behavioral and Economic Sciences		10.00	15.90	5.90	59.0%
Office of Polar Programs			0.00	0.00	N/A
Subtotal, Research and Related Activities	N/A	$10.00	$23.25	13.25	132.5%
Education and Human Resources	N/A		$1.00	1.00	N/A
Total, Human and Social Dynamics	N/A	$10.00	$24.25	14.25	142.5%

Totals may not add due to rounding.

Long-term Goals: For the next five years, NSF will emphasize research and education related to *Human and Social Dynamics*. The intellectual goals of the effort are to:

- Develop a comprehensive, multidisciplinary approach to understanding human and social dynamics;
- Exploit the convergence in biology, engineering, information technology, and cognition to advance our understanding of human behavior and performance at both the individual and social levels;
- Refine our knowledge of decision-making, risk, and uncertainty, and to learn how to translate this knowledge into improved decision-making;
- Develop the broad range of infrastructure needed to support transformative interdisciplinary research. Examples include collaboratory research networks, large-scale experimental laboratories, cognitive neuroimaging centers, national and international topic-focused research sites, and innovative research platforms such as real and modeled virtual communities;
- Create accessible large-scale data resources and advance methodological frontiers, including agent-based modeling, complex network analysis, non-linear dynamics, computer-assisted qualitative analysis, multi-level, multi-scalar analysis and measurement research and technologies. These will provide the foundation for social and behavioral investigations for the next decade.

Long-term Funding for Human and Social Dynamics

(Dollars in Millions)

FY 2002 Actual	FY 2003 Request	FY 2004 Request	FY 2005	FY 2006	FY 2007	FY 2008
N/A	$10.00	$24.25	$35.00	$55.00	$70.00	$80.00

FY 2004 Areas of Emphasis: In FY 2004, NSF plans to invest $24.25 million in interdisciplinary research on *Human and Social Dynamics* with special attention to the priorities described below.

- **Enhancing human performance** – Research on behavior, cognition, development, emotion, language, neuroscience and social interaction, in conjunction with advances in biology, engineering, robotics and information technology, will aid the development of approaches for enhancing human performance. Research on organizations, markets and informal groups will advance our understanding of how social structure interacts with human capacities to encourage or impede optimum performance.

- **Decision-making under uncertainty** – Research will focus on decision-making in normal and crisis circumstances, the implications of distributed versus centralized decision-making systems; and risk assessment and management; and the development of databases, decision-support, 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.

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

- **Modeling human and social dynamics** – Many aspects of human and social dynamics may be seen as complex networks: examples include social groups, large organizations, communication grids and economic systems. It is also possible to study group and societal behavior that results from numerous

individual or small group actions and decisions. Advances in statistics and modeling theory are making the analysis of these and other complex realities of social interaction possible. This area of emphasis includes the development and application of stochastic agent-based modeling, complex social network analysis, and techniques for modeling of human behavior and interaction using innovative information and engineering technologies.

- **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 include the use of the global positioning system (GPS) for highly precise locational specification; the development of geographic information systems (GISs) for gathering, analyzing, and presenting spatial data; and ever-expanding communications capabilities associated with the Internet and related media. The potential for using mobile devices and integrated sensors/transmitters for information gathering as well as for communications has only begun to be exploited. This area of emphasis will sponsor research using these technologies to explore human and social dynamics as well as research aimed at improving existing tools and making them more accessible.

- **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, capacity for security, and overall quality of life depend on a general 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 students globally. At the same time, many K-12 graduates are ill-prepared to respond to the demands of today's world, fewer citizens 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 capacity to perform 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. These issues must be addressed 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 is designed to capitalize on its experience with a variety of programmatic investments over the years by integrating the most effective of them, premising program designs on research findings bearing on science, mathematics, engineering, and technology learning, and broadening participation throughout. The focus is a highly synergistic and interconnected enterprise that will require the active involvement of researchers and educators at all levels and from every science and engineering discipline.

NSF has a long tradition of innovation in mathematics, science, engineering, and technology 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, 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.

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 connections across elementary, middle and high school for a seamless K-12 experience for all learners;
- Improve coordination and vertical integration of NSF programs along career paths to ensure a holistic education for all students;
- Focus on models for attracting and retaining 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, and from graduate study to careers;
- Promote both institutional and multi-institutional networking, partnerships, alliances and collaborations, to achieve results of mutual benefit; and
- Pursue research on 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.

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 for encouraging U.S. students to participate in science and engineering fields. The successful Research Experiences for Undergraduates (REU) investment broadly impacts students across all sectors. REU awards support individual investigators and site directors in offering hands-on research experiences for undergraduates. In these activities, students benefit from personal mentoring in career skills and opportunities and elect, in significant numbers, to continue in science or engineering

as a result. Institutions involved in the Louis Stokes Alliances for Minority Participation (LSAMP) investment produce 70 percent of the underrepresented minority science and engineering baccalaureate degree recipients. The Alliances for Graduate Education and the Professoriate (AGEP) program has encouraged a substantial increase in graduate degrees in just a few years. Centers of Excellence in Science and Technology (CREST) support research capacity in minority-serving institutions. Together, these programs advance undergraduates, graduate students, and build research capacity. When coupled with support for Historically Black Colleges and Universities (HBCUs) and Graduate Teaching Fellowships in K-12 Education (GK-12), the Math and Science Partnership (MSP), Major Research Instrumentation (MRI), and other projects, integrated sets of these programs can have substantial impact on a campus and on advancement of U.S. students, over and above what is envisioned by any one of them. 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 also be important contributors to integrative campus programs. Integrative Institutional Collaborations will enable institutions to craft complementary activities that weave together, vertically integrate, and augment support from existing programs, creating a seamless route of advancement for students from the K-12 through post-doctoral levels – a result that is much greater than the sum of its parts.

- **Faculty for the Future.** This program will enhance both preparation and professional development for K-12 teachers and the professoriate. Importantly, it is aimed at offering K-12 and higher education faculty the opportunity to hone the skills necessary 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 the education of new K-12 and higher education faculty, particularly those aimed at attracting and retaining members of underrepresented groups. These efforts may include development of new cost-effective tools that will enhance learning and allow students and faculty to participate in research, including use of simulation and Internet access to specialized research environments, and adaptation of 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 that will strengthen the learning-through-research environment of the MSI.

- **Workforce Research**. As the educational environment increases in complexity, young people and adults have many options for pursuing a degree or for enhancing their employability and opportunity for advancement. While many programs and activities are known to elicit interest in science and engineering and to reinforce decisions to pursue careers in those fields, the decisive factors in career choices remain elusive. Additional research is needed to determine what experiences or strategies 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 the factors that influence 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 2002 Actual	FY 2003 Request	FY 2004 Request	FY 2005	FY 2006	FY 2007	FY 2008
N/A	N/A	$8.50	$30.00	$50.00	$65.00	$75.00

FY 2004 Investment: In FY 2004, NSF will initiate this priority area by investing $6.5 million in Integrative Institutional Collaborations and $2.0 million in Workforce Research. The FY 2004 investment is intended to prepare the community for a robust focus on this priority investment over the subsequent five years.

Math and Science Partnership

NSF's FY 2004 budget provides $200.0 million for the President's Math and Science Partnership (MSP) program, the same as requested in FY 2003. The MSP program responds to a growing national concern – the lackluster performance of U.S. children in mathematics and science. *No Child Left Behind*, which enunciates the President's vision for K-12 education, articulates this concern and identifies the main underlying factors for the poor performance of U.S. students: too many teachers teaching out of field, too few students taking advanced coursework, and too few schools offering challenging curricula and textbooks.

MSP builds on the nation's dedication to improve mathematics and science education through support of partnerships that unite the efforts of local school districts with faculties of colleges and universities – especially disciplinary faculties in mathematics, science, and engineering – and with other stakeholders. MSP seeks to improve student outcomes in mathematics and science for all students, at all K-12 levels. As the achievement of students rises, MSP expects to significantly reduce achievement gaps in mathematics and science education among diverse student populations.

To achieve these long-term outcomes, the MSP program supports the development, implementation and sustainability of promising partnerships among: mathematics, science, engineering and education faculty and their institutions of higher education; administrators, teachers and guidance counselors in K-12 schools and school systems; and other important stakeholders to:

- Ensure that all K-12 students have access to, are prepared for, and are encouraged to participate and succeed in challenging curricula and advanced mathematics and science courses;
- Enhance the quality, quantity and diversity of the K-12 mathematics and science teacher workforce; and
- Develop evidence-based outcomes that contribute to our understanding of how students effectively learn mathematics and science.

The first competitions for (a) MSP *Comprehensive* and *Targeted* projects and (b) MSP *Research, Evaluation and Technical Assistance* (RETA) projects were held in FY 2002 and resulted in seven *Comprehensive* awards, seventeen *Targeted* awards and twelve RETA awards. Collectively, the funded *Comprehensive* and *Targeted* projects and RETA projects constitute the *MSP Learning Network*, a network of researchers and practitioners studying and evaluating promising strategies to improve K-12 student achievement and other student outcomes in mathematics and science. The *MSP Learning Network* activities are expected to deepen our understanding of how students effectively learn mathematics and science such that successful approaches can be broadly disseminated and emulated in educational practice.

MSP *Comprehensive* projects implement change in mathematics and science educational practices in both higher education institutions and in schools and school districts to result in improved student achievement

across the K-12 continuum. Projects are distinguished by the range and variety of lead institutions and partners involved. The Washington University MSP, for example, partners the university with five school districts, the St. Louis Science Center, and the St. Louis Zoo. The El Paso MSP involves not only the University of Texas at El Paso and twelve independent school districts, but also the Office of the Mayor of El Paso and the Hispanic and Black Chambers of Commerce.

Targeted projects focus on improved K-12 student achievement in a narrower grade range or disciplinary focus in mathematics and/or science. The partnership housed at the University System of Maryland, for example, targets science in grades 9 through 12, while the California State University-Fullerton partnership targets mathematics in grades 6 through 12.

- SUNY-Brockport teams with the Rochester City School District and the Brighton Central School District, with the Shodor Foundation and the Krell Institute as additional partners. A Computational Mathematics, Science and Technology (CMST) approach to learning science will be employed in which students and teachers engage in fieldwork, laboratory experiments, mathematical modeling, computer simulation and visualization. CMST employs mathematical models to describe physical phenomena, therefore bringing a new perspective to the usefulness of mathematics as a tool in real life. A challenge program incorporating CMST will provide tools and motivation for 200 7^{th} through 12^{th} grade students under the supervision of participating teachers. In addition to the collaboration and new strategies for problem solving, an important component of the professional development program for mathematics and science teachers is a four-week summer institute each year, serving a total of 240 teachers. In addition, there is a master's degree program for 30 teachers. Preservice education programs at SUNY - Brockport are being revised and new courses are to be introduced with a focus towards improving the quality, quantity and diversity of the new teacher workforce.

Research, Evaluation and Technical Assistance (RETA) projects provide large-scale research and evaluation capacity for the *MSP Learning Network*, and provide *Comprehensive* and *Targeted* awardees with assistance in the implementation and evaluation of their work.

- The Council of Chief State School Officers has established a collaborative research team involving the Wisconsin Center for Education Research and the American Institutes for Research to address the following research questions: (1) To what extent is the quality of the professional development supported by MSP consistent with a research-based definition of quality? (2) What effects do teachers' professional development experiences have on instructional practices and content taught in math and science classes? Are high-quality professional development activities more likely than lower-quality activities to increase the alignment of content with state standards and assessments? (3) How can MSP projects use study findings to improve professional development and the content and instruction of mathematics and science classes?

In FY 2003, MSP continues support for new *Comprehensive* and *Targeted* awards and a combination of research, evaluation and technical assistance grants and contracts, informed by assessments of lessons learned from the FY 2002 efforts. In FY 2004, MSP adds a new activity for *Teacher Institutes for the 21st Century*, with a focus on developing master teachers who have deep content expertise in mathematics, science, and related technologies, who are excited about newer developments in these fields, and who have the disciplinary depth and stature to motivate students towards continued study of mathematics and science in advanced courses.

The U.S. Department of Education sponsors numerous programs that support the President's education initiative, and NSF and the Education Department will continue to collaborate on appropriate program linkages to manage the federal investment in science and mathematics education for the greatest effectiveness. In FY 2002, NSF and ED co-funded one MSP *Comprehensive* award and one *Targeted* award.

Federal Crosscuts

NSF will continue its active participation in federal crosscut areas in FY 2004, supporting research and education in the U.S. Global Change Research Program at $188.30 million, the Networking and Information Technology Research and Development program at $723.60 million, and the National Nanotechnology Initiative at $248.99 million. In addition, in FY 2004, the Administration's Climate Change Research Initiative (CCRI), first proposed in FY 2003, will be funded at $25.0 million. 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

Developing "a diverse, internationally competitive and globally engaged workforce of scientists, engineers and well-prepared citizens."

The linkage of research and learning is a defining characteristic of all NSF investments. NSF activities directly involve over 200,000 people including researchers, graduate students and post-doctorates engaged in cutting-edge research and teachers and students at all grade levels. Support for programs specifically addressing NSF's Strategic Goal of People totals $1.15 billion in FY 2004, an increase of 6.1 percent over the FY 2003 Request. This increase is driven by funding for graduate fellowship and traineeship programs and focused efforts to broaden participation in the science and engineering enterprise. FY 2004 also marks the third year of the President's Math and Science Partnership (MSP), which promotes partnerships among states, local school districts and universities to strengthen K-12 mathematics and science education. The FY 2004 Request provides $200.0 million for MSP in keeping with the original five-year plan for this program.

Support by Level of Education
(Dollars in Millions)

	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	Change Amount	Change Percent
PreK-12	317	373	363	-10	-2.8%
Undergraduate	253	243	267	24	9.9%
Graduate and Professional	329	376	430	53	14.2%
Other Support	96	94	93	-1	-1.1%
Total, People[1]	$995	$1,087	$1,153	$66	6.1%

Totals may not add due to rounding.
[1]Total does not include $57.31 million in FY 2002, and an estimate of $65.68 million in FY 2003 from H-1B Nonimmigrant Petitioner Fees. Legislation for this activity expires in FY 2003.

The funds associated with the Foundation's People goal primarily address education and training opportunities for the current and future scientists and engineers and the instructional workforce in science, technology, engineering, and mathematics (STEM). NSF's other strategic goals, Ideas and Tools, also advance the People goal. Education is an integral component of all research projects, as the skills and training needed for the next generation of scientists, engineers, and technologists are provided within the context of the research experience and the state-of-the-art tools used in these efforts.

The Foundation places a high priority on formal and informal STEM education at all levels -- preK-12, undergraduate, graduate, professional, and public science literacy that engages people of all ages in lifelong learning. NSF programs are intended to increase opportunities for all students to learn mathematics and science, prepare for and complete higher education, join the workforce as competent and contributing members, and become well-informed, science-literate citizens.

PreK-12 Education

The FY 2004 NSF Request for preK-12 programs is $362.87 million, a decrease of $10.39 million or nearly 3 percent from the FY 2003 Request of $373.26 million. The decrease reflects the consolidation of

the Foundation's Rural Systemic Initiatives program and the Urban Systemic Program into NSF's teacher enhancement activities.

- The Math and Science Partnership (MSP) builds on the nation's dedication to improve K-12 mathematics and science education, through support of partnerships that unite the efforts of local school districts with faculties of colleges and universities -- especially disciplinary faculties in mathematics, science and engineering -- and with other stakeholders. MSP seeks to improve student outcomes in mathematics and science for all students, at all K-12 levels. NSF is requesting $200.0 million for MSP for FY 2004. The success of the partnerships will be measured through performance indicators such as increasing student participation in advanced courses in mathematics/science and student success in passing advanced placement exams, and increasing the numbers of prospective teachers who major in mathematics or science. Comprehensive projects designed to continuously improve student achievement in math and science from the earliest grades through grade 12 will reach over a million students in 11 states as part of the first round of this program. An additional 600,000 students will be reached through more targeted projects focusing on either science or mathematics at particular grade bands. The Comprehensive and Targeted projects constitute one component of the MSP program. A second component focuses on research, evaluation and technical assistance (RETA) in support of the Comprehensive and Targeted projects. A third component is expected to focus on teachers who will provide intellectual leadership in their schools and districts through the *Teacher Institutes for the 21st Century*. All MSP-funded projects contribute to the *MSP Learning Network*, a network of researchers and practitioners studying and evaluating promising strategies to improve K-12 student achievement and other student outcomes in mathematics and science. *MSP Learning Network* activities will deepen our understanding of how students effectively learn mathematics and science such that successful approaches can be broadly disseminated and emulated in educational practice. Additional information regarding MSP can be found in the Education and Human Resources section.

Undergraduate Education

The FY 2004 Request for programs to improve undergraduate education is $267.33 million, an increase of $24.12 million, or 9.9 percent, over the FY 2003 Request of $243.21 million. Highlights in FY 2004 include:

- NSF's Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) totals $19.97 million, an increase of $6.0 million, or 43 percent, over the FY 2003 Request level of $13.97 million. HBCU-UP provides awards to enhance the quality of undergraduate STEM programs through curricular reform and enhancement, faculty development, research experiences for undergraduates, upgrading of scientific instrumentation, and improvement of research infrastructure.

- Funding for the Louis Stokes Alliances for Minority Participation (LSAMP) program totals $32.73 million, an increase of 23 percent, or $6.20 million, over the FY 2003 Request of $26.53 million. The program strengthens and encourages STEM baccalaureate degree production of students from underrepresented populations by utilizing the knowledge, resources, and capabilities of a broad range of organizations from the academic, federal, and commercial sectors. The effectiveness of LSAMP is demonstrated by significant increases in the number of minority students in STEM fields earning baccalaureate degrees.

- The Science, Technology, Engineering and Mathematics Talent Expansion Program (STEP), established in FY 2002, is funded at $7.0 million in FY 2004, an increase of $5.0 million or 250 percent over the FY 2003 Request of $2.0 million. Under STEP, grants to colleges and universities

are provided to establish programs to increase the number of undergraduate math and science majors. In addition to STEP, NSF will continue to support the Noyce Scholarship program at the FY 2003 Request level of $4.0 million.

- The FY 2004 Request includes $16.18 million for the Federal Cyber Service: Scholarship for Service (SfS) program, an increase from the FY 2003 Request of $5.0 million, or about 45 percent. SfS provides scholarships to students in the fields of information assurance and computer security in return for a commitment following graduation to work for a federal agency. The program's goal is to increase the capacity of the U.S. higher education enterprise to produce professionals in these fields. Supplemental funding of $19.30 million was provided in FY 2002, recognizing the program's role in the homeland security effort.

- NSF's Foundation-wide Research Experiences for Undergraduates (REU) program requests funding of $45.58 million for FY 2004, an increase of $750,000 over the FY 2003 Request of $44.83 million. REU supports active research participation by undergraduate students and seeks to expand student participation in science and engineering research areas supported by NSF, whether disciplinary, interdisciplinary, or educational in focus.

- For FY 2004, NSF's Workforce for the 21st Century priority area will focus on attracting students, especially those students who have traditionally been underrepresented, to science, technology, engineering and mathematics (STEM) disciplines. Examples of possible activities include integrating research and education through hands-on research experiences for high school students and/or undergraduates across disciplines, providing for partnerships with non-academic S&E employers to offer internships and in-service learning, and conducting research on factors determining students' career choices. The Foundation is requesting $8.50 million to launch the initial phase of this priority area.

Graduate and Professional Education

The FY 2004 Request for graduate and professional programs totals $429.89 million, an increase of $53.50 million or 14.2 percent over the FY 2003 Request of $376.40 million.

- Increasing the stipend level and the number of students in the three NSF-supported graduate education programs are high priorities of the Foundation in FY 2004. In FY 2003, NSF requested a stipend level of $25,000 for Fellows and Trainees in the Graduate Research Fellowships (GRF) program, the Integrative Graduate Education and Research Traineeships (IGERT) program, and the Graduate Teaching Fellowships in K-12 Education (GK-12) program. For FY 2004, NSF is proposing to raise stipends to an annual amount of $30,000, starting in academic year 2004-2005, and to increase the number of students in these programs to nearly 5,000.

    - NSF's GRF program will increase by $17.24 million overall to $97.80 million in FY 2004. This flagship program selects and supports the most promising science and engineering students in the U.S. and provides support for stipends and cost of education allowances for their graduate education. Approximately 2,550 students will be supported in FY 2004.

    - The GK-12 program supports graduate and advanced undergraduate students in science and engineering as content resources for K-12 teachers while providing students the opportunity to develop teaching skills. Funding will increase by $8.65 million to a total of

$50.10 million. A new competition is supported with this increase, which will bring the program to about 900 graduate students.

- Support for the IGERT program will increase by $13.31 million to $67.10 million in FY 2004. In addition to raising stipends, approximately 1,500 IGERT students will be supported through the program. IGERT is distinguished from other training programs in that it has a strong emphasis on interdisciplinary training, innovation in graduate education, and broadening participation of underrepresented groups.

- Support for the Faculty Early Career Development (CAREER) program will total $128.33 million, an increase of $5.65 million from the FY 2003 Request of $122.68 million. This NSF-wide activity emphasizes the early development of academic careers by presenting this award to new faculty who are poised to become academic leaders of the future.

- Funding for ADVANCE, to increase the participation and advancement of women in all fields of science and engineering, will increase by $4.02 million, or 23 percent, to $21.16 million in FY 2004. ADVANCE is an integral part of the Foundation's multifaceted strategy to help realize a diverse science and engineering workforce.

- Postdoctoral Faculty Fellowships, a new program funded at $3.0 million in the Engineering Activity, will provide 15 promising postdocs with opportunities to enhance interdisciplinary research expertise and learning pedagogy needed to become outstanding new research faculty. The Office of Polar Programs is also initiating a new postdoc program, proposed in FY 2004 at $1.20 million, which is targeted to encouraging underrepresented groups to study emerging scientific frontiers in polar areas. In addition, the Advanced Studies Institutes program within SBE's Office of International Science and Engineering will provide funding to bring together graduate students and postdoctoral fellows from the United States and selected developing countries to explore cutting-edge areas of research.

Other Support

The FY 2004 Request for other People-related activities is $92.78 million, a decrease of $1.05 million.

- The Partnerships for Innovation (PFI) program will be funded at $10.0 million in FY 2004, an increase of $5.0 million over the FY 2003 Request. The PFI program builds innovation capacity by linking new knowledge and knowledge-rich workforce to economic growth and other societal benefits through the partnership endeavors of a diverse range of colleges and universities, private sector firms, local, state, and federal government entities and other organizations.

- Informal Science Education activities will be supported at $50.0 million in FY 2004, a decrease of $5.0 million. Projects included in this activity promote the general public's understanding of science, technology, engineering, and mathematics through media (e.g., print, film, television) and informal science organizations (e.g., museums, parks, zoos, libraries, community groups). Priorities include outreach to smaller communities and underrepresented groups.

- Evaluation efforts will be funded at $11.64 million, a $1.0 million decrease from the FY 2003 Request. NSF's evaluation program is designed to support evaluative studies that build the knowledge base about effective STEM education policy and practice, and to increase the size and capacity of the evaluation community. The modest reduction for evaluation is due to the increased presence of a significant research, evaluation and technical assistance component in MSP.

- The Program for Gender Equity in Science, Mathematics, Engineering, and Technology (PGE) will be funded at $9.96 million, a decrease of $550,000 from the FY 2003 Request. This decrease is offset by a $4.02 million increase in the Request for the ADVANCE program described above. The generally low participation of women in science, technology, engineering, and mathematics is a national concern. PGE is committed to overcoming barriers that have discouraged the early and continuing interest in STEM, and to developing interest, knowledge, and involvement of girls and young women in these fields.

- The Research in Disabilities Education (RiDE) program, formerly the Program for Persons with Disabilities (PPD), will be funded at $5.28 million, the same as the FY 2003 Request. RiDE supports efforts to increase the participation and achievement of individuals with disabilities in STEM education and careers. Methods and products of focused research awards are incorporated in program-sponsored regional alliances. The alliances serve to inform educators, government and industry about proven-good practices in the classroom, promote broader awareness and inclusion of disabilities issues, and define specific areas of human learning in need of further attention by the research community.

FY 2004 PERFORMANCE GOAL FOR PEOPLE

The following table summarizes NSF's FY 2004 Performance Goal for PEOPLE. For additional information, see the FY 2004 Performance Plan.

STRATEGIC OUTCOME GOAL	NO.	*ANNUAL PERFORMANCE GOAL*[A]	FY 2004 AREAS OF EMPHASIS	
			PROSPECTIVE REPORTING: INVESTMENTS IN EMERGING OPPORTUNITIES	**RETROSPECTIVE REPORTING, AS RELEVANT**
PEOPLE **Developing "a diverse, internationally competitive and globally engaged workforce of scientists, engineers, and well-prepared citizens."**	**III-1**	***NSF's performance for the PEOPLE Strategic Outcome is successful when, in the aggregate, results reported in the period demonstrate significant achievement in the majority of the following indicators:*** • Development of well-prepared researchers, educators or students whose participation in NSF activities provides experiences that enable them to explore frontiers or challenges of the future; • Contributions to development of a diverse workforce through participation of underrepresented groups[B] in NSF activities; • Development or implementation of other notable approaches or new paradigms[C] that promote progress toward the PEOPLE outcome goal.	❑ Math and Science Partnership ❑ Priority Area: - Workforce for the 21st Century ❑ Graduate Student Support	❑ PreK-12 Education, e.g., - Systemic Reform ❑ Undergraduate Education, e.g., - REU ❑ Graduate and Professional Development, e.g., - IGERT - GK-12 - CAREER ❑ Centers for Learning and Teaching (CLT) ❑ Broadening Participation, e.g., - Partnerships for Innovation - Historically Black Colleges and Universities – Undergraduate Program - Louis Stokes Alliances for Minority Participation

A This performance goal is stated in the alternate form provided for in GPRA legislation.
B For example, women, underrepresented minorities, persons with disabilities or underserved institutions.
C For example, broad-based, program-wide results that demonstrate success related to improved math and science performance for preK-12 students, or professional development of the STEM instructional workforce, or enhancement of undergraduate curricular/laboratory/instructional infrastructure, or highly synergistic education and research activities, or international collaborations, or communication with the public regarding science and engineering.

Highlights of Recent Accomplishments (People)

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

Fostering Broader Participation in STEM. NSF has actively promoted coordination between the Louis Stokes Alliances for Minority Participation (LSAMP) program and the Alliances for Graduate Education and the Professoriate (AGEP) program. The level of achievement in LSAMP alliances formed around the nation during the past ten years provides an excellent avenue to expand the number of underrepresented minority candidates joining the professoriate, and an important opportunity for maximizing graduate education is the tracking and routing of LSAMP students into AGEP. The *Minority Graduate Education at Mountain States Alliance* (MGE@MSA), funded by AGEP has enrolled 329 African American, American Indian, and Hispanic students in science, mathematics and engineering doctoral programs. After the first year of MGE@MSA, 43 doctoral degrees in these disciplines were awarded to program participants, up 87 percent from the 23 produced in the baseline year. The overall five-year goal of the project is to triple the number of underrepresented minority doctorates to achieve an annual rate of 69 by the year 2004. This goal was set following nine years of successful experience in mentoring minority students through Arizona State University's LSAMP project. For 2001-2002, *ASU's Mountain States Alliance* increased the number of MGE@MSA faculty mentoring participants from 51 to 179, and student participants from 129 to 238.

Multimedia science experience for children, educators, and families reaches more than one million households. In January 2002, *DragonflyTV,* a new weekly science magazine television show, was launched and is now seen by over 1,000,000 households nationwide. *DragonflyTV* is a multimedia science experience for kids, educators, and families. The show involves real kids doing real science and gives children and scientists a national forum where they share the excitement of scientific discovery. More than 90 percent of 5th graders and 87 percent of 6th graders said they understood the *DragonflyTV* investigations. In small group discussions, these children were able to describe investigations in detail, and offer ideas for new investigations of their own. The project includes an interactive website, http://pbskids.org/dragonflytv/index.html; Teacher's Guides that reach over 40,000 classrooms; and community outreach efforts to schools, Boys and Girls Clubs of America, and other youth organizations.

Participation of K-12 teachers in summer research projects results in significant improvement in students' scores on standard exam. K-12 teachers participate in summer research projects at MIT's radio Haystack Observatory, and then develop lesson plans for their classrooms based on their experiences. The final report on this grant contains the following paragraph: "Mindy Lekberg began testing her RET unit on molecular structure using radio astronomy, and reported that her students' scores on a standard American Chemical Society Test Bank Exam increased 13 mean points from 1997-1999. In addition, the head of the Science Department at Chelmsford High School informed us that one of Lekberg's REU lesson plans will be adopted by all of the physical sciences teachers once it is tested and finalized. Finally, Lekberg organized a 90-minute program for 275 ninth-grade physical sciences students in which the centerpieces was the use of the Haystack 37-meter telescope via the Internet from Chelmsford High School to image Cygnus A, observe the nature and properties of electromagnetic radiation, and discuss molecular emission from our galaxy using the water, ammonia and methanol lines."

Integration of engineering concepts and language in social science and humanities courses. Faculty in the Materials Science Department at MIT host a series of summer workshops for professors at liberal arts colleges. The Summer Institute (SI) assists faculty at liberal arts colleges in introducing materials science and engineering to their undergraduate curricula. It brings together MIT faculty, faculty from undergraduate liberal arts institutions, and MIT graduate students in a modular, case study format that combines materials science and engineering with social science and humanities fields. A pivotal aspect of

this project is the leverage gained in teaching educators who will bring the perspectives and methodologies of materials science and engineering to a much broader and diverse public audience than is usually present at engineering institutions.

ATE Regional Center Created in California. An Advanced Technological Education project that has grown to incorporate a new ATE Regional Center is the *California Regional Consortium for Engineering Advances in Technological Education (CREATE)*, based at the College of the Canyons in Los Angeles County, California. CREATE was formed as a joint effort of seven community colleges and over 70 high tech engineering technology employers to develop a regional approach to the preparation and training of engineering technicians. In 1997, all of the seven colleges in CREATE were challenged by a dichotomy between low enrollment in their credit electronics programs and a high demand from employers for highly skilled engineering technicians. Partnership with industry to develop programs tied to industry standards and certifications has resulted in an unprecedented level of success for the CREATE colleges, their students, and the industry partners. Over 10,000 students have been trained in CREATE engineering technology courses. New instructors have been hired and 115 new courses and 30 new credit certificate and degree programs have been State-approved and implemented. New equipment has been donated by industry and government partners (Strasbaugh, Procter and Gamble, NAVSEA) so that they can now outsource their training to the community colleges, college laboratories have been renovated by industry personnel (PG&E), and college instructors have been trained on industry sites at industry cost (Boeing) to make the curricula meet state-of-the-art industry requirements. Economic development impact has included the high rate of student placement in paid internships and jobs, and employers who report that the CREATE program has allowed them to compete favorably on large contracts (Aerospace Dynamics, Inc.) and remain in California (Xircom) because of the trained technicians made available by the project. http://www.create-california.org/

Internship program in marine sciences for African-American teachers. The Dauphin Island Sea Laboratory (DISL) is operated by the Alabama Marine Environmental Sciences Consortium. The faculty studies a variety of problems in oceanography and marine biology, and they provide advice to industry, government, and the public. DISL serves Alabama's research and instructional needs in the marine sciences. Students at all educational levels, including K-12 pupils, undergraduate and graduate students, teachers-in-training, elder hostel participants, and the general public, benefit from the programs offered at DISL. DISL is an NSF-REU site, and the laboratory is developing a minority internship program in marine science, the first of its kind in Alabama. In addition, this year the lab has developed a program to bring in African American teachers as interns for the summer to learn the material presented in the Discovery Hall displays, assist in teaching at each grade level, assist in the field-based programs and be mentors for the young students. These opportunities go beyond traditional methods of teaching and curriculum enhancement and will blaze a trail for minority teachers in marine science.

K-12 Education: GLACIER. This project focused on the development of a website designed for the general public (http://www.glacier.rice.edu/) and on development of an inquiry-based, thematic curriculum that integrates into the traditional middle school earth, ocean and space science curriculum. GLACIER uses ongoing research in the Antarctica to deliver science content in the areas of geologic principles, glacial geology, geomorphology, geography, meteorology, oceanography and environmental science. Requisite mathematics and hands-on explorations are included. Students are assigned the role of scientist and connect to on-line databases and with Antarctic researchers to conduct their investigations. GLACIER integrates with, and replaces portions of, the traditional middle-school sciences curriculum. Collaborators include educators from Texas, Colorado, Massachusetts, and Maine, participants in Teachers Experiencing Antarctica (TEA), and researchers involved in the West Antarctic Ice Sheet Initiative and funded through OPP.

An Integrated Curriculum for Intelligent Microprocessor-Based Mechanical Systems. The University of Notre Dame is developing a new curriculum that combines traditional discipline elements and embedded computing in all forms of mechanical systems. These experiences will better prepare students to use the sensing, actuation and control technologies resulting in the explosive growth of intelligent mechanical systems. During the past year every freshman, sophomore and senior (about 200 students in the Aerospace and Mechanical engineering degree programs) have been involved with hands-on projects associated with intelligent, autonomous engineering systems. The project engages faculty from various mechanical engineering disciplines who have limited experience with these new technologies, develops infrastructure and facilities to support student learning activities, and collaborates with industry to integrate elements of intelligent, embedded computing systems across the curriculum. A new Intelligent Systems and Automation Learning Laboratory has been developed and 12 courses will be modified to demonstrate applications or develop techniques for smart mechanical systems. Applications include control of medical equipment, specialized intelligent toys, rocket telemetry, sampling the thermal distribution in a lake using a GPS guided autonomous boat and the design and fabrication of an automated floor cleaning apparatus.

Software Training for IT Instructors. In April 2002, the American Association of Community Colleges and the *National Workforce Center for Emerging Technologies*, an Advanced Technological Education (ATE) center of excellence at Bellevue Community College, launched a new effort to provide software training for information technology instructors at community and technical colleges across the country. During the summer of 2002, intensive week-long workshops were held in Washington and Texas, and sessions in ten more states will be added in 2003. The sponsors hope to bring similar training programs to all 50 states within the next five years. Instructors will be able to develop skills using Java, Linux, and network security software. The Microsoft Corporation has pledged $1.3 million, as well as software, to the project over the next two years. http://www.nwcet.org/

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, 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.

Number of People Involved in NSF Activities.

	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate
Senior Researchers	28,960	29,820	30,590
Other Professionals	12,060	12,180	12,640
Postdoctoral Associates	5,740	6,060	6,170
Graduate Students	26,170	27,440	28,690
Undergraduate Students	34,250	32,710	36,350
K-12 Students	11,460	13,640	14,640
K-12 Teachers	84,710	85,460	86,830
Total Number of People [1]	203,350	207,310	215,910

[1] Does not include individuals to be 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 of these postdoctoral associates 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

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

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

NSF Funding for Ideas
(Dollars in Millions)

	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	Change Amount	Change Percent
Centers	356	372	411	39	10.6%
Other Ideas	2,081	2,187	2,285	97	4.4%
Ideas, Total	$2,436	$2,559	$2,696	$137	5.3%

FY 2004 support for Ideas totals $2.70 billion, an increase of $136.59 million, or 5.3 percent, above the FY 2003 estimate of $2.56 billion. 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, and engineering.

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

In FY 2004, NSF will continue its efforts to increase the average size of awards. This effort will contribute to increasing the efficiency of the Foundation's merit review process and achieve greater cost-effectiveness for both NSF and the university community, consistent with the findings of the recent survey of NSF-supported principal investigators and institutions. The average grant size and duration will increase to $128,000 per year for 3 years.

The FY 2004 Request focuses on areas that build strength in the science and engineering disciplines, enable the development of new and emerging fields, and provide leadership to improve the health and continued vitality of the nation's science, technology, engineering, and mathematics (STEM) research and education enterprise.

The following are areas of emphasis within NSF's core research programs that will be supported in FY 2004.

- The physical sciences produce advances and associated analytical tools that bring progress to a host of areas - from the magnetic resonance imaging techniques that are now central to medical imaging to the fiber optic networks that enable today's high-speed communications. With renewed support for research and infrastructure for fields such as physics, chemistry, mathematics, and materials research, the nation will be able to take full advantage of recent investments in the health sciences and will also reap benefits in areas such as energy, agriculture, and the environment.

- 21st Century Biology capitalizes on recent advances in genomics, proteomics, informatics, computer science, mathematics, physics, chemistry, engineering and the earth and social sciences. Its fundamental characteristics are that it is multidimensional, multidisciplinary, information-driven, education-oriented and internationally engaged. The emphasis in FY 2004 will be Living Networks. This activity focuses on integrating knowledge, especially that generated through genomics projects, to achieve an understanding of life from the level of atoms to entire ecosystems.

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

- Measurements of cosmic microwave background radiation will continue, including its polarization at South Pole Station, permitting unprecedented observations of the early structure/development of the universe and setting new parameters for cosmological theory.

- An increase in core funding for sensors will enhance health and environmental monitoring and the efficiency of industrial processes. It will also augment homeland security capabilities while creating a workforce knowledgeable in the operation and deployment of sensor technologies. Areas of emphasis include sensor technologies research related to nano/micro-scale sensors, wireless communications, functional materials with selective adsorption capabilities, nondestructive evaluation, and remote sensing.

- Enhanced core funding on environmental issues will lead to an increased knowledge base for protecting and restoring the environment and for reducing energy consumption. Areas of emphasis include fundamental research on environmental issues including environmentally benign manufacturing and production processes; waste reduction and recycling; increasingly efficient combustion processes; innovative approaches to controlling greenhouse gases; industrial ecology; and the integration of life-cycle product design methodologies with manufacturing enterprise systems and tools to assess, manage, and restore stressed environmental systems.

- Research on cognitive science, computational linguistics, and human origins, and on the science and technology of risk analysis and decision-making under uncertainty will be continued with a special focus on the problematics of climate change and extreme events and on the integration of economic, sociological, psychological and technical data.

- Increased attention for studies of abrupt and rapid climate change is anticipated through interdisciplinary studies of ocean circulation combined with those of paleoclimate records to document the frequency, temporal resolution, and spatial extent of past rapid climate change.

- Multidisciplinary studies of the processes that govern water quality and quantity, the character and dynamics of the Earth's surface, and the interactive processes at the intersection of the geosphere and biosphere will continue.

- The field of Quantum Science and Technology (QST) is emerging from discoveries at the interface between classical and quantum phenomena in physics, chemistry, materials research, engineering and computation. Quantum phenomena are key to understanding the origins of the universe, the nature of chemical bonding, phenomena in nanoscale materials, and relationships between physical forces. QST has the potential to shape all areas of science from the geophysical and biological sciences, to information technology and nanoscale science and engineering, which in turn will drive the future of computing and communications. The next five to ten years is likely to see the emergence of QST as a key to 21st century technology.

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

- The Experimental Program to Stimulate Competitive Research (EPSCoR), a State-NSF partnership, will continue to support improvements in academic research competitiveness. In FY 2004, funding for EPSCoR through the Education and Human Resources Appropriation totals $75.0 million, equal to the level provided in the FY 2003 Request. Linkages between EPSCoR and other NSF-supported research activities are expected to invest an additional $30 million for projects in EPSCoR states.

- The Small Business Innovation Research (SBIR) program and the Small Business Technology Transfer (STTR) program are supported at mandated levels of at least 2.5 percent and 0.30 percent, respectively, of the agency's extramural research. SBIR will total $90.93 million, an increase of $11.95 million over the FY 2003 Request of $78.98 million, and STTR will total $10.22 million, an increase of $5.55 million over the FY 2003 Request of $4.67 million. Recent congressional action increased the mandated agency spending target for STTR from 0.15 percent to 0.30 percent of the agency's extramural research budget in FY 2004.

Also included within support for Ideas are funds for fundamental research within five of the Foundation's priority areas: Biocomplexity in the Environment, Information Technology Research, Nanoscale Science and Engineering, Mathematical Sciences, and Human and Social Dynamics.

Centers

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

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

- To include a strong educational component that fosters public understanding of science and provides research experiences for teachers as well as establishes a team-based cross-disciplinary research and

education culture to educate the nation's next generation of scientists and engineers to be leaders in academe, industry and government; and

- To develop partnerships with industry that bring fundamental advances to bear on national priorities and directly connects academic research and advanced education with the industrial innovation process.

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

NSF Centers Programs
(Dollars in Millions)

	Program Initiation (year)	FY 2002 # of Centers	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate
Center for Ecological Analysis and Synthesis	1995	1	$3	$3	$3
Centers of Research Excellence in Science and Technology	1987	11	$9	$9	$11
Chemistry Centers	1998	21	$14	$10	$20
Earthquake Engineering Research Centers	1988	3	$6	$6	$6
Engineering Research Centers and Groups[1]	1985	32	$61	$56	$60
Industry/University Cooperative Research Centers	1973	46	$5	$5	$5
State/Industry/University Cooperative Research Centers	1991	3	$0	$1	N/A
Information Technology Centers	2000	66	$73	$70	$74
Long-Term Ecological Research Program	1980	24	$19	$19	$19
Materials Centers	1994	29	$53	$53	$57
Mathematical Sciences Research Institutes	1982	6	$10	$14	$15
Nanoscale Science and Engineering Centers	2001	6	$11	$12	$19
Physics Frontiers Centers	2003	5	$10	$13	$13
Plant Genome Virtual Centers	1998	23	$32	$31	$32
Science and Technology Centers	1987	11	$44	$45	$45
Science of Learning Centers	2003	N/A	N/A	$20	$20
SBE Centers[2]	N/A	7	$6	$5	$13
TOTAL		294	$356	$372	$411

Totals may not add due to rounding.
[1] Funding for Nanoscale Science and Engineering Centers was previously reported in Engineering Research Centers & Groups.
[2] SBE Centers include the National Consortium on Violence Research, the Children's Research Initiative Centers, the Environmental Social and Behavioral Science Centers, the Climate Change Research Initiative Centers, and the Research Centers on the Human Dimensions of Global Change.

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

FY 2002 Estimates for Selected Centers
(Dollars in Millions)

	Number of Participating Institutions	Number of Partners	Total NSF Support	Total Leveraged Support	Number of Participants
Centers of Research Excellence in Science and Technology	62	44	$9	$9	2,900
Chemistry Centers	45	29	$14	$1	610
Earthquake Engineering Research Centers	71	55	$6	$14	648
Engineering Research Centers	383	522	$61	$86	3,622
Industry/University Cooperative Research Centers and State/Industry/University Cooperative Research Centers	85	603	$6	$62	1,374
Long Term Ecological Research Program	178	117	$19	$45	2,578
Materials Centers	79	315	$53	$71	4,931
Plant Genome Virtual Centers	62	9	$32	$6	2,160
Physics Frontiers Centers	8	7	$10	$2	244
Science and Technology Centers	100	211	$44	$23	2,140

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

Description of NSF Centers

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. The center was considered for renewal in FY 2000 and received an award for 6 years of additional funding. NSF's FY 2004 support for the CEAS program is $3.15 million.

Centers of Research Excellence in Science and Technology

The Centers of Research Excellence in Science and Technology (CREST) program upgrades the research capabilities of the most productive minority institutions. Through strong alliances with other universities and laboratories, the centers produce new knowledge and provide students with direct experience in science, technology, engineering, and mathematics. NSF will provide $10.88 million for CREST in FY 2004, an increase of $2.0 million (22.5 percent) over the FY 2003 Request of $8.88 million. This funding level will support 11 Centers in FY 2004.

Chemistry Centers

Chemistry Centers include the Environmental Molecular Science Institutes (EMSIs), the Collaborative Research Activities in Environmental Molecular Science (CRAEMS), Collaborative Research in Chemistry (CRC), and the Laboratory for Molecular Sciences (LMS). In addition, new centers, Chemical Bonding Centers (CBCs), will be launched to attack grand challenges in our understanding of the nature of the chemical bond. Chemistry Centers support a wide range of activities, from developing a molecular understanding of the environment to investigation of fundamental steps in chemical reactions. In FY 2004, NSF will provide $19.70 million, an increase of $9.31 million (89.6 percent) over the FY 2003 Request of $10.39 million, to support 12 new centers, bringing the total to 32 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 are located at the University of North Carolina, Cornell University, and New York University. A fourth center is a collaboration among four universities: Georgetown University, Northwestern University, University of Texas-Austin, and University of California-Los Angeles. In FY 2004, additional centers will be established, and support for the CRI centers will amount to $4.0 million of the $5.0 million total requested for the Children's Research Initiative.

Climate Change Research Initiative Centers

Three to five centers will be supported focusing on Risk Analysis and Decision Making in relation to global climate change as part of the government-wide Climate Change Research Initiative. The FY 2004 investment in these centers is estimated to total $4.50 million, with the expectation that continuing

support at this level will be provided annually for three additional years. The centers will involve interdisciplinary teams that will push the frontiers of research on risk analysis and decision making to enhance our nation's capacity to evaluate the risks associated with climate change and to develop policies and decisions based on realistic appraisals of risks.

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 2002, NSF provided nearly $6.0 million to three EERCs, which leveraged this support with $14 million from universities, three states, and industry. FY 2004 support is maintained at the FY 2003 Request level of $5.99 million.

Engineering Research Centers

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

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

An additional $86 million in support from industry, other federal agencies, universities, and ten states leveraged NSF support of $60.71 million in FY 2002. 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 2004, NSF will provide a total of $60.22 million, an increase of $4.0 million (7.1%) over the FY 2003 Request. 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. Following a new competition, 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 2004 support for two or 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.

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

Industry depends on the Industry/University Cooperative Research Centers (I/UCRCs) and State I/UCRCs to provide a steady stream of enabling technologies critical to advancing their manufacturing processes, information technology support systems, and new product lines. In FY 2002, there were 49 of these highly leveraged centers, representing a total NSF investment of about $5.83 million. NSF's investment generated $62 million in leveraged support and substantial "in-kind" contributions for the centers. Another indication of high payoff from the supporters of the I/UCRCs is that they have invested over $160 million per year to fund follow-up internal research and implementation activities in their organizations as a result of the centers' research results.

In FY 2004, NSF will provide $5.18 million for I/UCRCs, a decrease of $110,000 from the FY 2003 Request of $5.29 million. The Industry/University Cooperative Research Centers program will support 46 I/UCRCs.

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. In support of their long-term mission, some centers will 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 will foster research on distributed computing and applications. In FY 2004, NSF will fund approximately 73 Information Technology Research Centers at the level of $74.0 million, an increase of $4.0 million (5.7 percent) over the FY 2003 Request of $70.0 million for enhancements to existing centers.

Long Term Ecological Research Program

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

In FY 2003 NSF is supporting 24 LTER sites that are representative of major ecosystems, including two sites in Antarctica and two in Alaska, one in Arctic Alaska. The LTER program has taken the lead in

establishing a worldwide ecological research network by electronically linking the U.S. LTER network with research sites in Europe, Latin America, and the Asia/Pacific region.

NSF's FY 2004 support for the LTER program is $19.02 million, an increase of $350,000 (1.9 percent) over the FY 2003 Request of $18.67 million.

Materials Centers

Materials Centers support interdisciplinary materials research addressing fundamental problems of intellectual and strategic importance. They include Materials Research Science and Engineering Centers (MRSECs) and beginning in FY 2003 will also include International Materials Institutes (IMIs) and Partnerships for Research and Education in Materials (PREMs). The MRSECs have strong links to industry and other sectors; MRSECs, IMIs and PREMs all support research and educational partnerships with other institutions.

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 $71 million in FY 2002. Approximately 27 MRSECs will be supported in FY 2004 at a total of $48.96 million.

IMIs focus specifically on stimulating and supporting cooperative activities in various areas of materials research and education between U.S. investigators and their colleagues worldwide. Three new IMIs are proposed in FY 2003, increasing to five or six in FY 2004 for a total of $3.60 million.

In FY 2004, up to eight Partnerships for Research and Education in Materials (formerly Collaboratives for Materials Research and Education in the FY 2003 Request) will be supported at $4.0 million. PREMs will link minority-serving institutions with focused research groups, centers, and user facilities in materials research and support collaborations between them.

NSF's FY 2004 support for the Materials Centers is $56.56 million, an increase of $3.80 million (7.2 percent) over the FY 2003 Request level of $52.76 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 2004, NSF will provide $15.0 million, an increase of $1.0 million (7.1 percent) over the FY 2003 Request of $14.0 million.

Nanoscale Science and Engineering Centers

As part of the multiagency National Nanotechnology Initiative, NSF funded six centers in FY 2001 and two new centers focused on manufacturing at the nanoscale are proposed in FY 2003. 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 2004, NSF will provide continuing support to the eight centers at $18.91 million, an increase of $6.50 million (52.4 percent) over the FY 2003 Request of $12.41 million.

National Consortium on Violence Research

NSF supports the National Consortium on Violence Research (NCOVR), which is engaged in a program of capacity building in the violence research community. The Consortium's activities focus on training the next generation of researchers in interdisciplinary approaches to understanding interpersonal violence and to increase the participation of underrepresented groups in research on violence. NCOVR also seeks to facilitate collaborative methodological research and the promotion of intellectual exchange that cuts across disciplines. Support for FY 2004 will be maintained at the FY 2003 Request of $1.0 million.

Physics Frontiers Centers

The Physics Frontiers Centers program was initiated in FY 2001. These centers provide critical resources and needed infrastructure to exceptionally promising new areas of physics. They serve as focal points to help catalyze new fields, with the resources and infrastructure to enable development of the new tools and techniques needed, and facilitate exploration of new directions in a way that is not practical in individual investigator awards. Areas such as atom lasers, quantum information science, computational physics, biological physics, and astrophysics are particularly promising for such an investment. Interdisciplinary research will be a key element of this program, and each center will have a significant outreach and infrastructure component. In FY 2004, NSF will provide a total of $13.0 million, equal to the FY 2003 Request, for support of five centers.

Plant Genome Virtual Centers

The Plant Genome Research subactivity supported twenty-three Plant Genome Collaboratories or 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. NSF support for Plant Genome Virtual Centers in FY 2004 will total $31.70 million, an increase of $700,000 (2.3 percent) over the FY 2003 Request of $31.0 million.

Of 23 centers supported in FY 2002, 21 are continuations or renewals of virtual centers created in previous years; 2 are newly established centers. The 23 centers involve 191 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 62 institutions in 29 States. International collaborators are involved in a number of areas of center research including the potato, wheat, and model legume projects.

Research Centers on the Human Dimensions of Global Change

NSF has supported a consortium of Research Centers on the Human Dimensions of Global Change since FY 1995. The goals of these centers are to facilitate the progress of Human Dimensions of Global Change (HDGC) research; promote the education and training of researchers ranging from undergraduate

to postdoctoral levels; and foster interdisciplinary and multidisciplinary research collaborations on HDGC issues. FY 2003 is the final year of support for the two HDGC centers.

Science and Technology Centers

The Science and Technology Centers (STC) Integrative Partnerships Program supports innovation in the integrated conduct of research, education, and knowledge transfer in fields of basic science, mathematics, and engineering. STCs foster partnerships that build a new collaborative culture among researchers and educators at all levels in academia, industry, government laboratories, and other public and private organizations. The Centers provide opportunities to explore challenging and complex research problems that often require interdisciplinary expertise and high-risk approaches, access to state-of-the-art instrumentation and facilities, and a commitment of high levels of support for sustained periods of time. It is estimated that STC funding from other sources totaled approximately $23 million in FY 2002.

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 2004 support for the STC program is $44.91 million, a decrease of $190,000, from the FY 2003 Request of $45.10 million.

Science of Learning Centers

NSF's investment in Science of Learning Centers (SLC), proposed to begin in FY 2003, will build on the Foundation's support for learning research in multiple disciplines including biology, psychology, education, neuroscience, cognitive science, linguistics, computer and information science, robotics, mathematics and statistics, engineering, the physical sciences, and the social and behavioral sciences. SLCs will be organized around an integrated, unifying, multidisciplinary research focus or one that significantly advances disciplinary frontiers and be 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 must demonstrate an effective implementation strategy that will achieve all three of the SLC principal goals: (1) advancing the understanding of learning, through research on the learning process, the context of learning, and/or learning technologies; (2) strengthening the connections between science of learning research and educational and workforce development, in a manner that mutually advances both; and (3) building effective collaborative research communities with sufficient resources and organizational capacity to respond to new educational and workforce challenges, and capitalize on new research opportunities and discoveries. FY 2004 support for the SLCs totals $20.0 million, equal to the FY 2003 Request.

FY 2004 GPRA PERFORMANCE GOAL FOR IDEAS

The following table summarizes NSF's FY 2004 Performance Goal for IDEAS. For additional information, see the FY 2004 Performance Plan.

STRATEGIC OUTCOME GOAL	NO. ANNUAL PERFORMANCE GOAL[A]	FY 2004 AREAS OF EMPHASIS	
		PROSPECTIVE REPORTING: INVESTMENTS IN EMERGING OPPORTUNITIES	RETROSPECTIVE REPORTING, AS RELEVANT:
IDEAS **Enabling "discovery across the frontier of science and engineering, connected to learning, innovation, and service to society."**	III-2 ***NSF's performance for the Ideas Strategic Outcome is successful when, in the aggregate, results reported in the period demonstrate significant achievement in the majority of the following indicators:*** • Discoveries that expand the frontiers of science, engineering, or technology; • Connections between discoveries and their use in service to society; • Partnerships that enable the flow of ideas among the academic, public or private sectors; and • Leadership in fostering newly developing or emerging areas.	❑ Priority areas: - Biocomplexity in the Environment - Information Technology Research - Nanoscale Science and Engineering - Mathematical Sciences - Human and Social Dynamics ❑ Core research and education activities ❑ Science of Learning Centers	❑ Balance of portfolio, including projects that are innovative, high-risk, or multidisciplinary ❑ Priority Areas: e.g., Current - Biocomplexity in the Environment - Information Technology Research - Nanoscale Science and Engineering Former - Life and Earth's Environment - Information Technology for the 21st Century - Knowledge and Distributed Intelligence ❑ Core research and education activities ❑ Centers, e.g., - STCs, ERCs, MRSECs. ❑ EPSCoR

[A] This performance goal is stated in the alternate form provided for in GPRA legislation.

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.

Uranium-eating bacterium's surprising survival tactics. Genomic information enabled the discovery of how *Geobacter metallireducens*, a common soil bacteria that consumes metals - specifically, iron and manganese oxides and which was previously believed to be incapable of movement, is able to locate and home in on metals if a source of iron or manganese is not nearby. As *Geobacter's* genome was sequenced, it revealed evidence of genes for flagella, the whip-like structures that enable bacteria to move, and genes for sensing chemicals in the environment. Experiments confirmed that *Geobacter* could sense chemicals and produce flagella. The results are significant since motile *Geobacter* can be used to clean up petroleum spills, and may offer a more efficient and economic method for removing uranium from contaminated groundwater than the current practice of pumping water out of an area and removing the soil. *Geobacter* transforms uranium from a soluble form to an insoluble form, which doesn't readily leach into the groundwater and contaminate rivers.

Self-tightening bolts. At a laboratory at the Virginia Polytechnic Institute and State University, when bolts and screws are used, NSF-supported researchers also use sensors and washers made of the "smart" materials known as piezoelectric, or PZT, patches and shape memory alloys (SMAs) respectively. The former provide an electrical signal used for continuous monitoring of the mechanical load or torque on the bolt or screw, and when something changes, for example in response to vibrations, extreme loads, or perhaps something as simple as temperature induced changes that allow the nut to loosen, the SMA washer changes it shape to "take up the slack" and restore the tightness of the bolt to its design load.

Superconductivity. Conventional superconductivity in materials like lead and tin results from interaction of electrons with lattice vibrations (phonons). NSF-supported researchers have now used the facilities of the National High Magnetic Field Laboratory to show that superconductivity can also result from the existence of charge density waves in an organic material at low temperatures. This kind of superconductivity was first predicted to be possible in 1954. Such superconductivity had never been seen before. The sample had to be cooled to within one degree of absolute zero in a magnetic field five hundred thousand times as strong as the Earth's field.

Composite bone materials. An NSF project has developed a nanoscale self-assembly technique to create composite materials very similar to bone tissue. Specifically, new polymeric molecules that self-assembled on their own to form cylindrical nano-sized fibers. These fibers direct the growth of reinforcing minerals such as hydroxyapatite into an alignment that is very similar to that in natural bone. This new technique holds promise not only for development of artificial bone, but also for repairing nerve fibers, creating nano-electronic wires, or preparing high-strength polymeric composites. This result was published in *Science* and elicited major coverage in *Chemical and Engineering News* and other publications.

Discovery of largest asteroid in solar system. The largest asteroid in the solar system, orbiting far from the sun (a Kuiper Belt Object), even larger than Pluto's moon, Charon, was discovered with the Cerro Tololo Inter-American Observatory 4-meter telescope in Chile. This discovery, by astronomers visiting from Lowell Observatory, arose from collaboration with NASA to characterize these outermost objects with the objective of gaining fundamental information on the formation of the solar system.

Early history of whales. Three articles published in *Science* and *Nature* this year by two groups of scientists point out great advances being made in understanding the early history of cetaceans (whales).

Both groups arrive independently at the same startling conclusions about the early evolution of whales based on new fossil finds in Pakistan. Whales evolved approximately 50 million years ago from land-based even-toed ungulates (hoofed animals) rather than mesonychians (an extinct group of carnivorous ungulates) as has been traditionally believed. These fox- and wolf-sized four-footed ungulates were surface paddlers in the shallow seas of Eocene time and evolved into modern whales.

Opening of the Bering Strait. A U.S.-Russia collaborative research project determined the date of the Bering Strait's opening by studying *Astarte* clams found in southern Alaska. The results indicate that the Strait opened about 2 million years earlier than previously thought. The revised opening date will allow researchers to more accurately document ancient climates.

Molecular electronics. Molecular electronics is based on the notion that the molecular organization of matter can result in very different electronic properties than are seen in more traditional semiconductor structures. The critical issue has to do with how charge is shared between molecules (discrete nano-scale structures) and electrodes (continuous metals). The most general picture for how these things work focuses on the interface, and on transport at that interface. In this area, an NSF-supported group at Northwestern University has developed robust general theoretical methodologies for *designing* interfaces that would be most effective in producing charge flow in molecular nanostructures.

Adaptive optics. NSF began support of adaptive optics over 15 years ago. Today, adaptive optics is maturing into a very powerful tool for high spatial resolution imaging. A few years ago, astronomical adaptive optics were limited to correcting for atmospheric turbulence over a small area of about 6 arc-seconds and required that a bright star be in the field. Today astronomers have learned how to create an artificial star in the sky using lasers, and have learned enough about the dynamics of the turbulent atmosphere to measure and forecast correction over arc-minutes field of view for telescopes in the 10 to 20 meter size category.

Effects of increased atmospheric carbon dioxide. An NSF-supported project has discovered that rising levels of atmospheric carbon dioxide associated with global warming can interfere with plants' ability to incorporate certain forms of nitrogen. Nitrogen is an element that is key to producing proteins and nucleic acids such as DNA in plants. The researchers found that nitrate fertilizer is not nearly as efficient as ammonium fertilizer when atmospheric carbon dioxide levels are unusually high. This study suggests that a shift to increase ammonium availability might be needed in the coming years as atmospheric CO_2 levels increase.

Hidden damage to buildings from earthquakes. Earthquakes cause buildings and bridges to collapse and highways to crack, but much of their most severe damage does not meet the eye. University of Southern California researchers at the Multidisciplinary Center for Earthquake Engineering Research (headquartered at The University at Buffalo) have been seeking ways to make public utility systems more resilient in the face of earthquakes. The researchers, including geotechnical, structural, risk and electrical engineers and economists from multiple institutions and municipalities, identify elements that are at risk, evaluate the geotechnical causes of damage, and estimate potential losses due to continuing service outages. The system allows municipalities to anticipate areas of greatest damage, strengthen those vulnerable areas with preemptive repairs, develop better emergency plans, and respond faster in the event of an earthquake.

Detection of polarization in the cosmic microwave background. Scientists at the South Pole using the Degree Angular Scale Interferometer measured a minute polarization of the cosmic microwave background (CMB), the sky-pervading afterglow of the Big Bang. The polarization of the CMB was produced by the scattering of cosmic light when it last interacted with matter, nearly 14 billion years ago. The discovery verifies the framework that supports modern cosmological theory and indicates that

ordinary matter – humans, stars and galaxies – accounts for less than 5 percent of the universe's total mass and energy. The vast majority of the universe is made of a mysterious force that astronomers call "dark energy" which is as-yet undiscovered forms and objects.

Thin-film material may have important applications in drug synthesis. An NSF-supported team has developed a thin-film material with nanometer-sized cavities that serves as a molecular gatekeeper. The material can be manipulated to allow the passage of certain molecules but not others depending on size, shape and other properties. The scientists have also found a means of chemically transforming molecules within these cavities. The tiny cavities of the array serve as a filter, but in solution the cavities can also be used to encapsulate catalysts that chemically transform molecules. The next step is to combine the filtration and catalytic steps. This would allow conversion of plentiful low-cost hydrocarbon molecules into valuable complex molecules with potential applications such as selective drug delivery, synthesis of specialty chemicals or new types of semiconductors.

A new route for polymer synthesis. Kris Matyjaszewski received this year's American Chemical Society (ACS) Polymer Chemistry Award for his innovations through development of the new technique of Atom Transfer Radical Polymerization (ATRP). This new synthetic tool has found very widespread application all over the world and is considered the most robust method for creating many polymeric materials. This work has created a market in polymer synthesis that is expected to exceed $20 billion per year. His technique is now used by dozens of laboratories around the world.

Underwater gliders for 4-D measurement of bio-optical and chemical parameters. Scientists from the University of Maine and the University of Washington, in partnership with industry, have been developing new and advanced autonomous underwater vehicles (gliders) and biological sensors. Recent advances in sensor development will provide unprecedented views of the biology of the ocean, specifically phytoplankton, both in time and in space. NSF and the National Oceanographic Partnership Program currently support these efforts. The work with gliders is revolutionizing the way that measurements are being made in the coastal and open ocean waters and provide oceanographers with a 4-dimensional view of the ocean,

Advanced numerical hurricane model. An NSF-supported scientist, in collaboration with the National Oceanic and Atmospheric Administration, has developed an advanced numerical hurricane model. In addition to providing better understanding of ocean/atmosphere interactions, the numerical model developed has demonstrated significant improvement in storm intensity prediction compared to the previous operational (uncoupled) numerical model. The new system has been run in parallel with the prior model and the ocean coupling has improved hurricane intensity forecasts by about 25 percent. The National Weather Service has adopted the model developed under this award as their new operational model.

Supercritical carbon dioxide process – partnership with DuPont Teflon. DuPont Fluoroproducts has introduced the first commercial DuPont Teflon® fluoropolymer resins made using proprietary and fundamentally new manufacturing technology that replaces traditional water-based polymerization with a process based on supercritical carbon dioxide. According to DuPont, the new technology produces Teflon® with enhanced performance and processing capabilities, while generating less waste. The new products are being manufactured at the company's Fayetteville, N.C., plant in a new $40 million facility that started up in late 2000. The new technology was developed jointly by DuPont and scientists at the University of North Carolina, Chapel Hill. The fundamental chemical processes in supercritical carbon dioxide that form the basis of this new technology were developed with NSF support.

International long-term ecological research. South Africa has recently joined the ILTER Network by establishing a site in Kruger National Park. ILTER sites enable researchers to study an area's unique

attributes and to use long-term data to address new ecological challenges. The severe southern African floods in early 2000 caused widespread changes in the riverine forest vegetation and soils in Kruger Park. U.S. scientists are working with South Africans to study how the long-term recovery of these systems is influenced by large browsing animals such as elephants and by exotic invasive plants. Such long-term data may shape conservation policies for the growing elephant populations in southern Africa and provide insights to researchers and land managers who must deal with increasing numbers of invasive species.

Experimental Program to Stimulate Competitive Research (*EPSCoR*) program. Researchers in Kansas are considering critical questions in Homeland Security and attempting to mitigate future bioterrorism and biological hazards through the *Kansas Program for Complex Fluid Flow*. A dozen scientists at Kansas State University, the University of Kansas, and Wichita State University are gaining a better understanding of how air moves through a confined space occupied by people, such as a room or an aircraft cabin, and how particles or contaminants may be transported through the area and around objects.

Tools

Providing "broadly accessible, state-of-the-art and shared research and education tools."

In pursuit of its mission to provide a widely accessible, state-of-the-art science and engineering infrastructure, NSF invests in Tools. NSF provides support for large, multi-user facilities, which allow researchers access to essential facilities. Support for these unique national facilities is necessary to advance U.S. capabilities required for world-class research. NSF investments in Tools also include support for Internet-based and distributed user facilities, advanced computer resources, research networks, major research instrumentation, research resources, digital libraries, and large databases, all of which contribute to a state-of-the-art science and engineering infrastructure resource. Facilities and other tools supported are shown below:

Tools Funding
(Dollars in Millions)

	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	Change Amount	Change Percent
Facilities					
Academic Research Fleet	61.90	62.00	65.00	3.00	4.8%
Antarctic Facilities and Operations	123.38	128.70	144.29	15.59	12.1%
Cornell Electron Storage Ring	19.49	19.49	21.00	1.51	7.7%
Gemini	12.50	12.60	14.20	1.60	12.7%
Incorporated Research Institutions for Seismology	12.93	13.10	14.10	1.00	7.6%
Laser Interferometer Gravitational Wave Observatory	24.00	29.50	29.00	-0.50	-1.7%
Major Research Equipment & Facilities Construction[1]	122.41	136.28	226.33	90.05	66.1%
National Astronomy Facilities	88.36	84.33	93.43	9.10	10.8%
National Center for Atmospheric Research	77.59	74.87	80.09	5.22	7.0%
National High Magnetic Field Laboratory	24.97	24.00	24.50	0.50	2.1%
National Superconducting Cyclotron Laboratory	14.81	14.70	15.20	0.50	3.4%
Ocean Drilling Program/Integrated Ocean Drilling Program	31.50	30.00	15.40	-14.60	-48.7%
Partnerships for Advanced Computational Infrastructure	75.27	71.49	76.49	5.00	7.0%
Other Facilities[2]	42.43	63.54	87.29	23.75	37.4%
Other Tools					
Advanced Networking Infrastructure	47.60	46.62	46.42	-0.20	-0.4%
Cyberinfrastructure	0.00	0.00	20.00	20.00	N/A
Major Research Instrumentation	75.89	54.00	90.00	36.00	66.7%
National High Field Mass Spectrometry Facility[3]	1.06	0.99	0.00	-0.99	-100.0%
National STEM Digital Library	27.07	27.50	23.80	-3.70	-13.5%
Polar Logistics	97.85	94.07	97.07	3.00	3.2%
Research Resources	111.23	106.36	128.85	22.49	21.1%
Science Resource Statistics	16.18	23.36	24.47	1.11	4.8%
Science and Technology Policy Institute	3.99	4.00	4.00	0.00	0.0%
Total, Tools Support	**$1,112.41**	**$1,121.50**	**$1,340.93**	**$219.43**	**19.6%**

[1]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.
[2]Other Facilities includes support for the National Nanofabrication Users Network through FY 2003, the National Nanotechnology Infrastructure Network in FY 2004, and other physics, materials research, ocean sciences, atmospheric sciences, and earth sciences facilities.
[3]Support for the National High Field Mass Spectrometry Facility will be integrated into the National High Magnetic Field Laboratory in FY 2004.

The FY 2004 Request for Tools totals $1,340.93 million, a $219.43 million increase from the FY 2003 Request of $1,121.50 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.

To describe the life-cycle of a facility, the Foundation has adopted a set of distinct stages in its recently completed 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 – This stage includes construction and/or acquisition, system integration, commissioning, testing, acceptance, transition to operations, and management of these efforts; 3) Operations and Maintenance – This stage includes 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 – Decisions regarding continued support of a facility are made. During this stage 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.

MAJOR MULTI-USER RESEARCH FACILITIES

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, and through standard grants. In addition, NSF oversees the fleet through external review of proposals, site visits, ship inspections, and participation at UNOLS Council and sub-committee 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), the Port Captain (for shore-side facilities) 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, of which NSF is Chair) recently developed and published a report on the long-range plan for renewal of the academic fleet. The FY 2004 Request for the Academic Research Fleet totals $65.0 million, an increase of $3.0 million over the FY 2003 Request of $62.0 million. This increase will support the continued operation of the U.S. Academic Research Fleet.

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	$2.1	$44.8	$47.0
FY 1995	$0.6	$45.7	$46.3
FY 1996	$1.5	$41.5	$43.0
FY 1997	$0.0	$40.9	$40.9
FY 1998	$0.4	$40.2	$40.6
FY 1999	$0.0	$43.3	$43.3
FY 2000	$0.3	$45.1	$45.4
FY 2001	$2.3	$56.6	$58.9
FY 2002	$2.3	$59.6	$61.9
FY 2003 Req	$1.0	$61.0	$62.0
FY 2004 Req	$2.2	$62.8	$65.0
FY 2005 Est	$32.0	$70.6	$102.6
FY 2006 Est	$2.3	$72.7	$75.0
FY 2007 Est	$30.0	$72.8	$102.8
FY 2008 Est	$0.0	$74.0	$74.0

NOTE: Estimates for FY 2005 and beyond are placeholders only, and are not intended to reflect actual budget requirements.

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 FY 2005 and FY 2007 implementation estimates are for development of a new deep submergence vehicle and replacement of regional ships consistent with the FOFC plan.

- 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 through a cooperative agreement 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, and the ability of the operating institution to maintain cost effective operations.

Associated Research and Education Activities: Research utilizing the fleet is supported by NSF's research programs, and is subjected to NSF's standard merit review process utilizing review by peers. 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.

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 $55 million in FY 2002 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.

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: Antarctic Facilities and Operations integrate education and outreach activity with the research projects in Antarctica.

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 Division of Acquisition and Cost Support. 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 2004. 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	0.00	104.54	104.54
FY 1995	0.00	104.67	104.67
FY 1996	0.00	107.35	107.35
FY 1997	0.00	100.29	100.29
FY 1998	0.00	97.02	97.02
FY 1999	0.00	95.90	95.90
FY 2000	0.00	106.50	106.50
FY 2001	0.00	116.45	116.45
FY 2002	0.00	123.38	123.38
FY 2003 Req	0.00	128.70	128.70
FY 2004 Req	0.00	144.29	144.29
FY 2005 Est	0.00	148.04	148.04
FY 2006 Est	0.00	152.04	152.04
FY 2007 Est	0.00	156.30	156.30
FY 2008 Est	0.00	160.83	160.83

NOTE: Estimates for FY 2005 and beyond are placeholders only, and are not intended to reflect actual budget requirements.

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 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.

Renewal or Termination: N/A

Associated Research and Education Activities: The Antarctic infrastructure makes science possible - ranging from astrophysics to microbiology and climatology - in Antarctica 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: N/A

Cornell Electron Storage Ring (CESR)

Project Description: The Cornell Electron Storage Ring (CESR) is a facility that supports research in elementary particle and accelerator physics. CESR is an electron-positron storage ring that has provided important knowledge of the properties of the b quark. Funding for CESR also supports the associated detector (CLEO) for use in elementary particle physics research in the b-quark sector, as well as research in accelerator physics and superconducting radio frequency (RF) applications. Cornell University will modify the CESR colliding beam accelerator and upgrade the CLEO particle detector for operation over the energy range 1.5 GeV to 5.6 GeV per beam in order to address high-priority physics questions that can not be addressed elsewhere. The transformed collider and detector are named CESRc and CLEOc respectively.

Principal Scientific Goals: CESRc and CLEOc 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 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 manufactures a superconducting RF source to power synchrotron light sources. Also some of the Cornell High Energy Synchrotron Source (CHESS) users are from industry, including: pharmaceutical corporations (Rib-x Pharmaceuticals) and the research arms of chemical corporations (Eastman Kodak, Xerox) and automotive corporations (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: CESRc is managed by the Laboratory Director, with help from an Assistant Director and an Associate Director for Accelerator Physics. The CLEOc experiment is the sole CESRc experiment in particle physics, and this collaboration consists of users from about 20 U.S. institutions. The CESRc management interacts with the CLEOc collaboration through the collaboration spokesperson and executive board as needed, and there are monthly meetings of the collaboration that include CESRc management.

NSF oversight (PHY/MPS) is provided through annual site visits by NSF staff. Technical review of the award involves panel evaluation of the CESRc proposal, and by a site visit by NSF staff and external reviewers. The oversight process includes monthly and quarterly financial reports and program reports to the NSF; annual review by a Program Advisory Committee of outside physicists reporting to the Laboratory Director and NSF; and annual oral reports to the High Energy Physics Advisory Panel (advisory to NSF and the Department of Energy).

Current Project Status: Cornell University will modify the CESR colliding beam accelerator and upgrade 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. CESRc will also provide intense x-ray beams for the program in x-ray science at the Cornell High Energy Synchrotron Source (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 of the Mathematics and Physical Sciences Activity, the Biological Sciences Activity, and by the National Institutes of Health. The FY 2004 Request for CESR totals $21.0 million, an increase of $1.51 million over the FY 2003 Request of $19.49 million.

Funding Profile: The FY 2003 - FY 2008 estimated funding for CESRc and CLEOc 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 Req		19.49	$19.49
FY 2004 Req		21.00	$21.00
FY 2005 Est		21.00	$21.00
FY 2006 Est		20.00	$20.00
FY 2007 Est		18.00	$18.00
FY 2008 Est		8.50	$8.50

NOTE: Estimates for FY 2005 and beyond are placeholders only, and are not intended to reflect actual budget requirements.

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

- Implementation: These figures reflect an upgrade to CESR 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 5500 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.

Renewal or Termination: The current cooperative agreement expires in FY 2003. At this time, and subject to approval by the National Science Board, NSF expects to renew the program through a cooperative agreement that will expire in FY 2008. NSF does not expect to renew the program of CESR operations for elementary particle physics when the new agreement expires in FY 2008.

Associated Research and Education Activities: Cornell has held three staff workshops in Diversity Awareness in 2002. They have conducted "Expand Your Horizons" workshops for ~100 middle school girls over the last three years, involving 7 female graduate students and 1 female faculty member. They participate in "Saturday Academy," a group of ~25 minority grade and high school students meeting monthly. The Cornell Laboratory for Nuclear Science (LNS) sponsors a monthly Visiting Scientist series at a rural elementary school where 36 percent of the children are eligible for free school lunches. And they conduct an "Atoms for Kids" program at two rural elementary schools where ~30 percent of the students are similarly eligible for free school lunches. The laboratory trains graduate students in accelerator physics and has supported the development of superconducting radio frequency accelerating cavities.

Science Support: Approximately $3 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 collaboration includes researchers from 25 U.S. and foreign institutions. The CESR facility is also used by the materials research community (500-600 users per year, typically) for synchrotron radiation studies.

Gemini Observatories

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 will 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 percent 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 established by the International Gemini Agreement signed by the participating nations and 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, Division of Grants and Agreements, 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 is establishing 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 telescopes and, particularly, 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 now 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 2004 Request totals $14.20 million, an increase of $1.60 million over the FY 2003 Request of $12.60 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 percent share of the total project cost. Experience gained during the construction and integration of the Hawaii telescope allowed for an accelerated schedule in Chile.

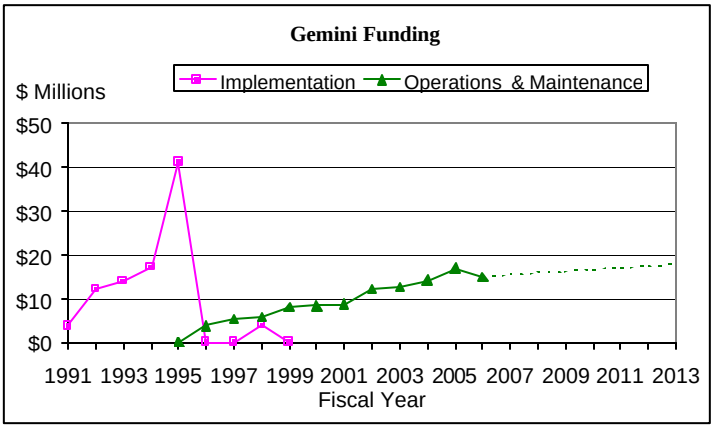
Gemini Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation[1]		Operations & Maintenance[1]		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 Req					12.60		12.60
FY 2004 Req[2]					14.20		14.20
FY 2005 Est[2]					16.82		16.82
FY 2006 Est[3]					14.76		14.76
FY 2007 Est[4]					15.49		15.49
Subtotal, R&RA	$12.00		$47.00		$126.32		$185.32
Subtotal, MREFC		$0.00		$45.00		$0.00	$45.00
Total, Each Phase		$12.00		$92.00		$126.32	$230.32

[1]Reporting of costs in these categories is as considered and reported by NSF in its response to OIG report 01-2001.
[2] 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.
[3]The current cooperative agreement ends in FY 2005. Estimates for FY 2006 and beyond reflect the anticipated growth of the operating budget being used by the Observatory and the Gemini Board for planning purposes. The anticipated lifetime of the Observatory is 25 years.
[4]A steady state of about $15 million annually is anticipated for the U.S. share of operations beginning in FY 2007.

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 million obligated for Gemini construction is the U.S. share of the total cost ($184 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 include 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 percent 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.

Renewal or Termination: The cooperative agreement for the support of Gemini operations is in its third year and 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 million, once the facility reaches full operations.

Incorporated Research Institutions for Seismology (IRIS)

Project Description: IRIS is a consortium of 96 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. The E&O program of IRIS will expand its educational displays, and provide more access to real-time data for educational purposes.

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 has had and continues to have close collaboration with industry in the area of seismic instrumentation and software development. NSF program staff encourage IRIS to continue its efforts to establish closer ties to industry, and follows these developments on a regular basis.

Partnerships: IRIS is heavily involved in partnership activities, many of them 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. IRIS GSN stations in many countries are designated as the official monitoring stations for nuclear test ban monitoring in those countries. International teams of scientists organize most PASSCAL projects overseas. IRIS membership in the FDSN and the designation of the IRIS Data Management System (DMS) as the international archive for broadband digital waveform data are additional examples of IRIS activity on the international scene. NSF envisions that IRIS will enlarge the scope of its international activities in the coming years. 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 (EAR/GEO), through its Instrumentation & Facilities Program (IF), has a major responsibility for providing IRIS with general oversight and monitoring to help assure effective performance and administration, as well as facilitating the work done by IRIS. IF/EAR also cooperates in the 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 96 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 2004 Request for IRIS totals $14.10 million, an increase of $1.0 million over the FY 2003 Request of $13.10 million.

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 Req	2.00	11.10	13.10
FY 2004 Req	2.20	11.90	14.10
FY 2005 Est	2.21	12.39	14.60
FY 2006 Est	2.30	12.00	14.30
FY 2007 Est	2.40	12.20	14.60
FY 2008 Est	2.50	12.30	14.80

NOTE: Estimates for FY 2005 and beyond are placeholders only, and are not intended to reflect actual budget requirements.

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 a yearly sum of unique visitors each month, 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 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 processes involving super-massive objects in the universe will produce gravitational radiation that will travel to Earth. Detection of gravity waves is of great importance both for fundamental physics and for cosmology. LIGO is designed to be the most sensitive gravitational wave detector ever built. LIGO 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 distances between test masses at the ends of the straight sections caused by a passing gravity wave. The distortion in space between the test masses caused by the gravity wave is

much less than the size of a hydrogen nucleus, implying a measurement of length change divided by the length of the interferometer arms of $h \sim 10^{-21}$. The size of the LIGO interferometers is required to meet this extreme requirement. These are by far the largest optical interferometers ever built.

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 gravity waves from a host of cataclysmic cosmic phenomena, we have never detected a gravity wave and measured its waveform.

The principal scientific goals of LIGO are to detect gravity 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. With the beginning of LIGO science runs in FY 2002, the number of graduate students is expected to grow. 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, Louisiana 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 and MIT 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, the Division of Grants and Agreements, and the Budget Division. The Project Advisory Team has been in existence since 1994.

Current Project Status: All three LIGO interferometers have been completed, locked, and operated in coincidence. FY 2002 was devoted to continuous improvement of the sensitivity of the interferometers and the first science run S-1 that accumulated nearly 100 hours of triple coincidence in the period from August 23, 2002 to September 9, 2002 with a strain sensitivity approaching 10^{-20} $(Hz)^{-1/2}$. Work on sensitivity improvements continues in FY 2003 in preparation for a much longer second science run S-2 scheduled to begin in February 2003. Recently strain sensitivities about ten times better than those observed in S-1 have been achieved (December, 2002). The FY 2004 Request for LIGO totals $29.0 million, a decrease of $500,000 over the FY 2003 Request of $29.50 million. This funding level reflects 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		Management & Operations		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					24.00		$24.00		$24.00
FY 2003 Req					29.50		$29.50		$29.50
FY 2004 Req					29.00		$29.00		$29.00
FY 2005 Est					30.00		$30.00		$30.00
Subtotal, R&RA	$47.56		$35.90		$181.10		$264.56		
Subtotal, MREFC				$236.00				$236.00	
Total, each phase		$47.56		$271.90		$181.10			$500.56

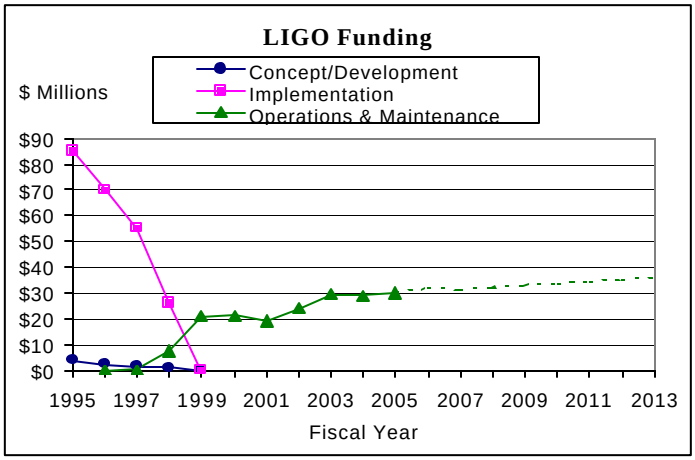
NOTE: A steady state of $30 million for operations is anticipated by the end of FY 2005, after the initial years of science operations. The expected operational lifespan of this project is about 20 years.

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 - $11.6 million (FY 1975-87); pre-construction R&D - $16 million (FY 1988-91); and ongoing R&D throughout construction - $20 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 second year and expires in FY 2006. NSF expects to renew the agreement at that time pending a satisfactory performance review.

Associated Research and Education Activities: Active Outreach programs have been developed at both the Livingston and Hanford sites. For example, the Livingston team has provided visual displays, hands-on science exhibits, and fun activities for students visiting the site. In the last three years an average of over 2000 students per year have taken advantage of this opportunity. More formal programs at the site 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 SURF/REU programs for college students. In addition to a set of similar on-site activities, the Hanford team has developed a Web-based Resource for teachers by teachers (grades 5 through 12) that includes information on research opportunities for schools, internships in public science education, and a set of classroom activities, lessons, and projects related to LIGO science.

Science Support: Along with direct operations and maintenance support for LIGO, NSF will support science and engineering research performed at the facility, through ongoing research and education programs. The annual support for such activities is estimated to be about $8.5 million once the facility reaches full operations.

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.

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) Account.

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 2004, funding is requested for the highest priority items, the ongoing projects identified in the following table. In addition, three new starts are requested in FY 2005 and FY 2006. In priority order, these are:

- Scientific Ocean Drilling ($76.85 million in FY 2005)
- Rare Symmetry Violating Processes ($30.0 million in FY 2006)
- Ocean Observatories ($24.76 million in FY 2006)

A total of $202.33 million is requested in FY 2004, an increase of $76.05 million over FY 2003, to support seven ongoing projects. Additional information on these projects can be found in the MREFC section.

MREFC Funding
(Dollars in Millions)

Projects[1]	FY 2002[2] Actual	FY 2003 Request	FY 2004 Request
Atacama Large Millimeter Array Construction	12.50	30.00	50.84
EarthScope: USArray, SAFOD, PBO	N/A	35.00	45.00
High-Performance Instrumented Airborne Platform for Environmental Research (HIAPER)	35.00	--	25.53
IceCube Neutrino Observatory	10.12	--	60.00
Large Hadron Collider	16.90	9.72	--
National Ecological Observatory Network	N/A	12.00	12.00
Network for Earthquake Engineering Simulation (NEES)	24.40	13.56	8.00
Polar Aircraft Upgrades	0.89	--	--
South Pole Station	15.55	6.00	0.96
Terascale Computing Systems[3]		20.00	--
Total, Major Research Equipment and Facilities (MREFC) Construction Account	$115.35	$126.28	$202.33

Totals may not add due to rounding.
[1]Additional funding for operations and maintenance of MREFC projects is provided through the Research and Related Activities Account.
[2]FY 2002 Actuals include $16.44 million in carryover from prior year appropriations for the South Pole Station Modernization project, the South Pole Station Safety and Environment project and the Polar Aircraft upgrades. $39.88 million appropriated in FY 2002 is carried over into FY 2003. This FY 2002 carryover will be reflected in the Current Plan following an FY 2003 appropriation.
[3]FY 2002 funding for Terascale in the amount of $35.0 million, was carried over into FY 2003 due to the NSB meeting schedule. The award was approved in October, 2002 and the funds have been obligated.

- 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).

- HIAPER is a multidisciplinary high-altitude research aircraft capable of conducting science at or near the tropopause with an extensive scientific payload and a range in excess of 6,000 nautical miles. HIAPER will be the only extant U.S. civilian research platform for intercontinental and transoceanic research flights above 43,000 feet. It will serve the entire geosciences community: atmosphere, cryosphere, biosphere, and hydrosphere.

- 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.

- Network for Earthquake Engineering Simulation (NEES) will upgrade, modernize, expand and network major facilities including shake tables used for earthquake simulations, large reaction walls for pseudo-dynamic testing, centrifuges for testing soils under earthquake loading, and field testing facilities.

- South Pole Station will be expanded to provide support infrastructure and utilities for 150 people, versus the original capacity for 110. This will accommodate increased interest in conducting research at the South Pole.

National Astronomy Centers

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 a federally funded research and development center (FFRDC) 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, last year it also held, in collaboration with NRAO, a summer school on single-dish radio astronomy techniques at Arecibo. This will be 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 in the Mathematics and Physical Sciences (AST/MPS) Activity. Management is via 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. Arecibo Visiting Committee meetings

(commissioned by Cornell) are attended by the NSF program manager, and committee reports are made available to NSF. Yearly status reports and long-range plans are presented by NAIC/Cornell representatives in 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 2004; an extensive review of the management of NAIC will occur before the expiration of the current cooperative agreement. Cornell has recently instituted a new oversight committee, at NSF's urging, to monitor the progress and management of NAIC and Arecibo Observatory. A search is currently underway for a new Director of NAIC. The FY 2004 Request for NAIC totals $12.10 million, an increase of $3.10 million over the FY 2003 Request of $9.0 million. This increase will support continued operation and maintenance of the renovated Arecibo telescope and the development of instrumentation to take advantage of its greater sensitivity.

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		11.11	11.11
FY 2003 Req		12.10	12.10
FY 2004 Req		10.30	10.30
FY 2005 Est		10.30	10.30
FY 2006 Est		10.30	10.30
FY 2007 Est		10.30	10.30
FY 2008 Est		10.30	10.30

NOTE: The current cooperative agreement expires in FY 2004. Estimates for FY 2005 and beyond are placeholders only, and are not intended to reflect actual budget requirements. GEO contributions for science support are 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.

- Operations and Maintenance: The current cooperative agreement with Cornell to manage NAIC expires in 2004. 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. Under an agreement currently under negotiation between NSF and NASA, NSF will assume primary funding responsibility for the program in FY 2005-2006.

Renewal or Termination: The current cooperative agreement expires in FY 2004; an extensive review of the management of NAIC will occur before the expiration of the current cooperative agreement by which time NSF will decide whether to renew or recompete the program. Funding amounts for FY 2005 and beyond will be determined through negotiation at that time.

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 provided $1.70 million in FY 2002 and will provide $1.80 million in FY 2004 by for ionospheric staff support and research. 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 New Mexico and 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: NOAO supports 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: NOAO promotes and enhances the education of undergraduate and graduate student researchers and outreach training for K-12 teachers. Some recent examples of outreach activities include: Project ASTRO, which matches astronomers with 4th to 9th grade teachers and community educators in the Tucson area who want to enrich their astronomy and science teaching; and the use of Astronomy in Research Based Science Education (RBSE), a summer workshop for middle and high school teachers.

Partnerships and Connections to Industry: The management organization of NOAO is comprised of 29 U.S. Member Institutions and 6 International Affiliate Members the Member Institutions of AURA,. 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 the Association of Universities for Research in Astronomy (AURA), Inc. 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 2004 Request for NOAO totals $38.60 million, an increase of $2.90 million over the FY 2003 Request of $35.70 million. NOAO funding includes $34.80 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.

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	Total, NSF
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		36.82	$36.82
FY 2003 Req		35.70	$35.70
FY 2004 Req		38.60	$38.60
FY 2005 Est		38.60	$38.60
FY 2006 Est		38.60	$38.60
FY 2007 Est		38.60	$38.60
FY 2008 Est		38.60	$38.60

NOTE: The current cooperative agreement expires in FY 2006. Estimates for FY 2007 and beyond are placeholders only, and are not intended to reflect actual budget requirements. TSIP funding is included.

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 construction of the Synoptic Optical Long-term Investigations of the Sun (SOLIS) telescope in 1998 – 2000.

- 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. Design and development is underway at the National Solar Observatory for an Advanced Technology Solar Telescope (ATST).

Renewal or Termination: The current cooperative agreement expires in FY 2006. A management review will be carried out three years into the current cooperative agreement 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 in Project ASTRO and intensive (multi-week) training of about 25 teachers per year through Teacher Learning through Research Based Science Education; K-12 numbers are not tracked but it is estimated that school groups make up about 10 percent of the roughly 75,000 visitors per year to public visitor centers at NOAO and NSO. 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 NSF Division of Elementary, Secondary and Informal Education (EHR), the NSF Division of Atmospheric Sciences (GEO), the Program for Education and Special Programs in the Astronomy Division (REU and teacher enhancement) (MPS), and the NSF Office of International Science and Engineering (INT). 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 and Socorro, New Mexico, with headquarters in Charlottesville, Virginia. These federally funded, ground-based observing facilities for radio astronomy are available to any qualified astronomer, regardless of affiliation, 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 has been extended to 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 after the expiration of this cooperative agreement. A renewal proposal from AUI for operations of NRAO will form the basis of a new 5-year cooperative agreement. The NRAO is engaged currently in three projects: the Expanded Very Large Array (EVLA); the Green Bank 100 Meter radio telescope; and the ALMA submillimeter radio telescope, which received approval as a Major Research Equipment and Facilities Construction project from the National Science Board, winter 2001. NRAO is the implementing organization of the ALMA project. The FY 2004 Request for NRAO totals $42.73 million, an increase of $3.10 million over the FY 2003 Request of $39.63 million. This increase will support continued improvements and enhancements to the EVLA and optimization of science operations of the Byrd Green Bank Telescope.

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 Req	5.00	34.63	$39.63
FY 2004 Req	5.00	37.73	$42.73
FY 2005 Est	5.00	37.70	$42.70
FY 2006 Est	5.00	37.70	$42.70
FY 2007 Est	5.00	37.70	$42.70
FY 2008 Est	5.00	37.70	$42.70

NOTE: The current cooperative agreement expires in FY 2004. Estimates for FY 2005 and beyond are placeholders only, and are not intended to reflect actual budget requirements.

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. The Expanded Very Large Array (EVLA) upgrade is in the second year of the 9-year project.

- 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.

Renewal or Termination: The current cooperative agreement expires in FY 2004. A recent management review led to the recommendation, approved by the National Science Board, that AUI continue as the managing organization of NRAO after the expiration of this cooperative agreement. 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 approximately 50,000 visitors each year to either the Green Bank or the Very Large Array facilities, including school field trips for K-12 students. Observatory professional scientific and engineering staff also visit classrooms regularly to provide an hour of 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 NSF 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. Facilities available to university, NCAR, and other researchers include an advanced computational center providing resources and services well suited for the development and execution of large models and for the archiving and manipulation of large data sets. NCAR also provides research aircraft, which can be equipped with sensors to measure dynamic physical and chemical states of the atmosphere. In addition, one airborne and one portable ground-based radar system are available for atmospheric research as well as other surface sensing systems.

Principal Scientific Goals: NCAR research programs 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 change, including interactions with other environmental systems; global and regional atmospheric chemistry including geochemical and biogeochemical cycles; the variable nature of the Sun and the physics of the corona; 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 for visiting scientists to conduct research and interact with NCAR scientists.

Principal Education Goals: NCAR disseminates information about the geosciences to students in K-12, undergraduate, and graduate schools, to postdoctorates, and to the general public. One way this goal is achieved is via educational tours and exhibits reaching tens of thousands of people every year. Professional training, innovative and award-winning science education websites as well as the recent establishment of the Office of Education and Outreach are further examples of the way NCAR's principal educational goals are attained.

Connections to Industry: NCAR works to develop new collaborations and partnerships with the private sector. To this end, the NCAR director has established a new external advisory council comprising influential leaders from all these sectors and charged them with improving dialog and developing more concrete plans for new alliances.

Partnerships: Research collaborations among NCAR staff and university colleagues are integral to its success as an institution, and the strength, variety, and frequency of its interactions with the university community provide metrics of the health of our programs. NCAR fosters and strongly supports these interactions through many approaches devised over the course of 42 years. Examples: 1) The National Wildland Fire R&D Program, which involves collaboration with the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), the Federal Aviation Administration (FAA) and a number of universities, are attempting to resolve the problem of fuel buildup, due to decades of effective fire suppression and housing growth at the wildland-urban interface, which have led to more frequent, serious confrontations between people and fires; 2) Terrestrial Impacts of Solar Output, which involves collaboration with the University of Colorado, Hampton University, the University of Wuppertal, Germany, the Institute of Volcanic Geology and Geochemistry, Russia, and the University of Munich, Germany, who are all studying the anthropogenic

effects in the upper atmosphere (where they are frequently much larger than in the lower atmosphere). Such research can provide important information on the magnitude of anthropogenically induced global change at lower levels in the atmosphere, while studies of the downward transport of solar variability effects through the atmosphere provide a basis for understanding the relative importance of solar and anthropogenic variability effects on biospheric global change.

Management and Oversight: NCAR is managed by the University Corporation for Atmospheric Research (UCAR), a university-governed and university-serving organization, with NCAR as its major engine of basic and applied research. UCAR works in partnership with NSF, the university community, and its other sponsors. NSF's Division of Atmospheric Sciences (GEO) along with the Division of Grants and Agreements, provide oversight of this facility via a cooperative agreement with the managing institution, the University Corporation for Atmospheric Research (UCAR). The cooperative agreement consists of terms and conditions and numerous task orders known as Scientific Program Orders (SPO). These SPOs allow NSF to provide oversight and accountability for the activities taking place under the cooperative agreement.

Current Project Status: NCAR has retired the Electra Aircraft from operation, due to age. The ELDORA Radar formerly attached to the Electra has been removed and installed on the Naval Research Lab P-3 aircraft for use during field campaigns. NCAR, managing the acquisition of the Major Research Equipment and Facilities Construction (MREFC) project High-Performance Instrumented Platform for Environmental Research (HIAPER), has contracted with Gulfstream, Inc. to procure a G-V aircraft that should be ready for operation in FY 2005. For further information on HIAPER, see the MREFC chapter. The NCAR's Scientific Computing Division has entered into a contract with IBM to increase its capacity from one to nine Teraflops over the next two years. The FY 2004 Request for NCAR totals $80.09 million, an increase of $5.22 million over the FY 2003 Request of $74.87 million. This increase will support research on Earth's natural cycles, including climate system modeling and the operation of the computation facilities for the Climate Simulation Laboratory; projects within the U.S. Weather Research Program (USWRP) and the National Space Weather Program (NSWP); and continued development of observational and computational capabilities. Included in these amounts, the Division of Mathematical Sciences of the Directorate for Mathematical and Physical Sciences (MPS) provides $1.27 million annually from FY 2002-04 to support statistics and modeling at NCAR.

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 and 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 Req	$3.84	$71.03	$74.87
FY 2004 Req	$3.94	$76.15	$80.09
FY 2005 Est	$4.04	$78.70	$82.74
FY 2006 Est	$4.14	$82.80	$86.94
FY 2007 Est	$4.24	$87.00	$91.24
FY 2008 Est	$4.30	$91.50	$95.80

NOTE: Estimates for FY 2005 and beyond are placeholders only, and are not intended to reflect actual budget requirements. MPS contributions for statistics and modeling are included.

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

- Implementation: In FY 1999-2001, a project to refurbish the Mesa Lab building located in Boulder, CO was funded and project tasks undertaken. The refurbishment includes upgrade of various facets of NCAR's facilities such as handicap accessibility, wiring systems, structural upgrades, etc. The project will be completed in FY 2005.

- 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 decision to renew, recompete, or terminate NCAR is informed by a mid-award review of both science activities as well as management effectiveness. Based on the outcome of this intermediate review, a competitive proposal may be invited for continued operation of NCAR. This proposal is subject to NSF's standard merit review procedures, and is reviewed by both individual reviewers as well as a focus panel composed of preeminent researchers and managers. The current cooperative agreement expires in FY 2003. A proposal for continuing support of NCAR has been submitted and is currently under review. Future funding levels beyond FY 2004 will be dependent on the outcome of that review.

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 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 students and teachers. Teachers 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.

NCAR Participation

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]

NOTE*: All numbers in italics are estimates.*
[a] The increased number of teachers in FY 2002 includes participants at a series of workshops.

Science Support: NSF-supported researchers with grants totaling approximately $20 million used the aircraft operated by NCAR in FY 2002. This support comes from programs within the Atmospheric Sciences Subactivity for proposals submitted for use of the NCAR aircraft during field campaigns such as IHOP, ACE-ASIA, etc. NSF-supported researchers with grants totaling approximately $30 million used the computational resources of NCAR. Many principal investigators request computing time at the NCAR facility to accomplish analyses required to evaluate results from their proposed work.

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, and engineering. It is the largest and highest powered magnet laboratory, outfitted with the world's most comprehensive assortment of high-performing magnet systems. Many of the unique facilities were designed, developed, and built by the world's premier magnet engineering and design team of 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: NHFML 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 physics, chemistry, materials science, engineering, biology, and geology.

Principal Education Goals: NHFML promotes science education and assists in developing the next generation of science, engineering, 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 truly unique interdisciplinary learning environment and has had a national impact in curriculum development.

Partnerships and Connections to Industry: The Magnet Science and Technology (MS&T) Division of the NHMFL is a national resource with broad responsibility to develop magnet and magnetic materials in response to national needs, such as building advanced magnet systems for the NHMFL site, 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 and magnet research. 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 laboratories on a variety of magnet technology projects, including advancement in magnet materials. 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 collaborations as one of its mission objectives "to engage in the development of future magnet technology." NHMFL researchers and staff work aggressively to engage private partners in diverse magnet technology areas. In 2001 the laboratory collaborated with 40 private sector companies, 22 national laboratories and federal centers, and 23 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 the appropriate administrative and financial oversight and 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 outreach activities, including education and corporate affiliates. Through the organizational network, the director receives guidance and recommendations from staff, the participating institutions, and user communities. Two external committees meet on a regular basis 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 the user community and 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 has been 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) and 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 for National Facilities was established in the NSF Division of Materials Research with primary responsibility for NSF administration and oversight of the NHMFL.

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. 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 NSB 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 further progress review will be conducted early in 2003. The FY 2004 Request for the NHMFL totals $24.50 million, an increase of $500,000 over the FY 2003 Request of $24.0 million. This increase reflects the phasing in of support of the National High Field Mass Spectrometry Facility supported as a separate facility in FY 2003 by the Chemistry Subactivity of MPS.

Funding Profile: All 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 Req	6.50	17.50	24.00
FY 2004 Req	6.50	18.00	24.50
FY 2005 Est	6.00	19.00	25.00

NOTE: Estimates for FY 2005 are placeholders only, and are not intended to reflect actual budget requirements.

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 facilities that are continuously upgraded. Recent examples include the development of an ultrasonic spectrometer for use in pulsed high magnetic fields at the Los Alamos facility of the NHMFL, the design and development of an innovative magnet providing uniform transverse field at over 20 tesla, and a design effort currently underway to upgrade six sites with higher field magnets. In addition, the high temperature superconducting magnets and materials group, in collaboration with Oxford Superconductor Technologies, is designing and building a high-field insert coil for the 20 tesla wide-bore resistive magnet. The pulsed magnet group continues to deliver capacitively driven magnets for the Los Alamos user facility, and improved lifetime of the 60 tesla 15 mm bore magnets has been achieved.

- 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 increase for operations and maintenance from FY 2001 to FY 2002 is a significant part of the ramp-up to the increased level of support required as the NHMFL moves from a primary focus on magnet development to a primary focus on research, outreach, and support for users. Specifically, the increased level of maintenance and operations support from FY 2001 to 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.

Renewal or Termination: A progress review is scheduled for FY 2003. In FY 2005 a proposal for a further five years' support will be considered either by renewal or recompetition.

Associated Research and Education Activities: The NHMFL base award currently includes approximately $500,000 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 $106,000 per year supports a Research Experiences for Teachers program. The number of K-12 students and teachers, undergraduates, and graduates students participating in these programs is shown in the following table:

NHMFL People Participation

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 Est	3,500	15	17	1,319

[1]Undergraduates participating in the Summer Minority Program and/or Research Experiences for Undergraduates (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

The NHMFL serves as a national resource for education not necessarily reflected by these numbers. For example, in FY 2001, 70 undergraduates and 33 post doctoral students were supported at NHMFL by other funding sources outside the base award.

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 external sources. The number of user projects averages around 400 per year. The average number of users (individuals) per user project is 5.

Additional Information: The NHMFL is an ongoing partnership between NSF and the State of Florida. The following table shows matching funds over the past ten years and commitments through the end of the current award, together with contributed funds from industry, the State of Florida and other sources over the same period.

Leveraged Funds

	Matching	Contributed	Total
FY 1994[1]	6.13	23.17	29.30
FY 1995	6.29	5.81	12.10
FY 1996	6.44	4.86	11.30
FY 1997	6.60	5.90	12.50
FY 1998	6.60	5.90	12.50
FY 1999	6.72	5.78	12.50
FY 2000	6.91	5.60	12.50
FY 2001	6.78	2.35	9.14
FY 2002	6.78	2.36	9.14
FY 2003 Est	6.78	3.10	9.88
FY 2004 Est	6.78	2.41	9.19
FY 2005 Est	6.78	2.46	9.24
Total $M	79.61	69.70	149.31

[1] FY 1994 contributed funds include State of Florida funds to complete construction.

The NHMFL currently provides facilities to more than 300 user groups annually. The final table shows the average size of user groups (number of individuals per group) at the various facilities of the NHMFL over the past three years. The DC (Direct Current), EMR (Electromagnetic Resonance) and Geochemistry facilities are at Florida State University. There are NMR (Nuclear Magnetic Resonance) facilities at Florida State University and at the University of Florida. The High B/T (Field/Temperature ratio) facility is at the University of Florida; and the Pulsed Field facility is at Los Alamos National Laboratory.

Average User Group Size by Facility

Facility	Average Group Size
Direct Current	4.4
Pulsed Current	4.7
High B/T (Field/Temperature ratio)	9
Nuclear Magnetic Resonance	3.3
Electromagentic Resonance	3.8
Geochemistry	2

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 applic ations 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.

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. Specific license agreement with Accel Corporation 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 2004 Request for the NSCL totals $15.20 million, an increase of $500,000 over the FY 2003 Request of $14.70 million. This increase will support full 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 Req		14.70	14.70
FY 2004 Req		15.20	15.20
FY 2005 Est		15.20	15.20
FY 2006 Est		15.20	15.20

NOTE: Estimates for FY 2005 and beyond are placeholders only, and are not intended to reflect actual budget requirements. Estimates for FY 2007 and beyond will be dependent upon a new cooperative agreement.

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 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 & development) with the remainder used to operate and maintain the facility for all users. The facility currently (FY 2003) serves about 150 users per year. This is expected to grow to about 250 users/year following the upgrade.

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 Undergrad column are the approximate number of undergraduates 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 1994	27	45	4	6
FY 1995	25	50	6	6
FY 1996	29	50	7	6
FY 1997	31	65	9	15
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

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 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) is an international partnership of scientists and research institutions organized to explore the evolution and structure of Earth as recorded in the ocean basins. ODP provides 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 *JOIDES Resolution* is the drillship used to collect geologic samples from the floor of the deep ocean basins through rotary coring and hydraulic piston coring. The logs and samples of the cores are made available to qualified scientists throughout the world for research projects.

Principal Scientific Goals: ODP activities explore the Earth's crust beneath the ocean revealing the composition, structure, and history of the submerged portion of Earth's surface. Through core samples and downhole logging, the drilling program has advanced our understanding of the Earth by providing insights to the pathways of fluids through the oceanic lithosphere, global climate change from areas as diverse as the equator and the Arctic, past changes in sea-level, tectonic evolution of oceanic crust, and the complex processes related to the evolution of passive margins.

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 ODP, 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: The drillship is owned and operated by Transocean Seco-Forex, a leading offshore drilling contractor. Schlumberger International, a leading oilfield service company, provides logging services. In addition, scientists from industrial research laboratories participate in ODP cruises, are members of the program's scientific and technical advisory committees, and have supplied data for planning and interpretation of drilling results.

Partnerships: More than 20 countries participate in ODP. NSF provides 60 percent of the funds for program operations, with the remaining 40 percent provided through contribution of funds from the international members. Due to the expense of the facilities necessary to drill deep in the oceanic crust, as well as the need for global coverage, international cooperation is of mutual advantage to participating countries. The ODP is one of the largest science programs in existence today.

Management and Oversight: NSF and agencies in twenty-one other member nations have signed Memoranda of Understanding with the NSF sponsor, The Ocean Drilling Program. NSF manages the program through a prime contract with Joint Oceanographic Institutions, Inc. (JOI), a consortium of major United States oceanographic institutions. JOI has a subcontract with Texas A&M University, which acts as the ODP Science Operator. JOI also has subcontracts with Lamont-Doherty Earth Observatory, which acts as the ODP Logging Operator and the ODP Site Survey Databank. Scientific advice and guidance for ODP is provided through the JOIDES scientific advisory structure. The JOIDES Science Advisory structure is responsible for providing scientific advice and guidance for ODP, and consists of the JOIDES Executive Committee (EXCOM) and a science advisory structure headed by the JOIDES Science Committee (SCICOM). The JOIDES Office, under the direction of the SCICOM Chair, is responsible for the coordination of the JOIDES committees and panels, and for integrating the advice from the panel structure in a manner suitable for providing drilling and operational guidance to JOI.

The Ocean Sciences Subactivity (GEO) manages ODP for NSF. ODP is a program under the Marine Geosciences Section, with several program officers dedicated to its oversight. One of the program officers serves as the contracting officer's technical representative on the prime contract.

Current Program Status and Future Program Planning: Drilling activity under the Ocean Drilling Program is scheduled to end in September 2003, as reflected in the program funding profile below. Plans for a new program of scientific ocean drilling, the Integrated Ocean Drilling Program (IODP), are under consideration. The FY 2004 Request for ODP totals $8.40 million, a decrease of $21.60 from the FY 2003 Request of $30.0 million, which reflects the phaseout of this program.

Although ODP will terminate as planned, 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. 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 total capital cost required for the two vessels is approximately $600 million. The Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan has secured funding of approximately $500 million and is completing 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 outfitting and testing in 2003-2006, and will be available for IODP operations in 2007. NSF's planned contribution to the capital costs necessary to fully equip this program includes the acquisition, conversion and outfitting of a vessel suitable to achieve the goals of the light vessel requirement. Further information on this component of the IODP program can be found under Scientific Ocean Drilling in the MREFC Chapter. Finally, a European consortium of 15 countries is being organized to provide the short-term use of chartered drilling platforms for near-shore and Arctic objectives.

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 $7.0 million in FY 2004 for startup operations of the IODP program and for planning, design and development of the Scientific Ocean Drilling project through the R&RA Account. Further information on the future operations of IODP can be found under Scientific Ocean Drilling in the MREFC chapter.

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

ODP Funding Profile[1]
(Dollars in Millions)

	Implementation	Operations & 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	$29.50
FY 2001		$30.60	$30.60
FY 2002		$31.50	$31.50
FY 2003 Req		$30.00	$30.00
FY 2004 Req		$8.40	$8.40
FY 2005 Est		$5.90	$5.90
FY 2006 Est		$3.40	$3.40
FY 2007 Est		$3.10	$3.10
FY 2008 Est		$0.00	$0.00

NOTE: Estimates for FY 2005 and beyond are placeholders only, and are not intended to reflect actual budget requirements.
[1]Excludes funding for IODP and the acquisition component of the new program, Scientific Ocean Drilling, to be proposed through the MREFC Account. Please see the MREFC chapter additional information pertaining to IODP.

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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. Support for participation and drilling-related research performed by U.S. scientists is provided by NSF.

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 expires at the end of FY 2003, and at that time, the Ocean Drilling Program will officially end.

Associated Research and Education Activities: A breakdown by year and by categories 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.

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 Est	7,000	8,000	10,000	7,000

Science Support: NSF provides most of the support for the participation of U.S. scientists in the ODP. 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 to $18 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

Project Description: The PACI Program supports two partnerships: the National Computational Science Alliance (Alliance) and the National Partnership for Advanced Computational Infrastructure (NPACI).

Each partnership consists of a leading edge site, the National Center for Supercomputing Applications in Urbana-Champaign (Alliance) and the San Diego Supercomputer Center in San Diego (NPACI), and a significant number of partners. There are more than 60 geographically distributed partner institutions from 27 states and the District of Columbia associated with either Alliance or NPACI or both. The two leading edge sites, together with the partners who support smaller versions of these computers and provide access to experimental systems, constitute a distributed, metacomputing environment connected via high-speed networks. In addition, the partners contribute to the infrastructure by developing, applying and testing the necessary software, tools, and algorithms which contribute to the further growth of this "national grid" of interconnected high-performance computing systems.

Principal Scientific Goals: The PACI Program has four major goals: (1) to provide access to a diverse set of advanced and mid-range computing engines and data storage systems and experimental machine architectures; (2) to promote enabling technologies, by developing both software tools for parallel computation and software to enable use of the partnership's widely distributed architecturally diverse machines and data sources to effectively use the partnership's very large distributed systems; (3) to promote application technologies, by engaging groups in high-end applications to develop and optimize their discipline specific codes and software infrastructures and to make these available to the program as a whole, as well as to researchers in other areas; and (4) to provide education outreach and training, building growing awareness and understanding of how to use high performance computing and communications resources, and broadening the base of participation to help ensure the nation's continued world leadership in computational science and engineering.

Principal Education Goals: The three goals of PACI Education Outreach and Training Activity are: 1) to demonstrate the use of NSF PACI technologies and resources among diverse audiences by leveraging PACI thrust/team efforts; 2) to increase the participation of underrepresented groups, including persons with disabilities, in computer science, engineering, and information technology; and 3) to enable broad national impact in education, government, science, business, and society with systemic, sustainable, scalable programs.

Partnerships and Connections to Industry: The PACI program by definition is a partnership program. Each of the two leading edge sites has a large number of academic partner institutions. Some, but not all of the academic partners contribute computational resources to the PACI Program. Resource Partners include: University of Texas, Caltech, University of Michigan, University of California, Berkeley, University of New Mexico, University of Wisconsin, Boston University, and University of Kentucky. Other partner institutions contribute to the PACI efforts in enabling and applications technologies. In all, the Alliance has 57 partner institutions, and NPACI has 55 partners. There are also international partnerships. Examples of 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.

The PACI Partnerships have 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, Roebuck and Co.; Shell Oil Company; Arena Pharmaceuticals; BAE Systems; Brocade; Ceres, Inc; Computer Science Corp.; Pfizer; JVC; Lockheed Martin; and ESRI. They also have strategic technology partnerships with a number of companies including ANSYS, Inc.; Informix Corp.; Microsoft Corp.; SGI; Sun Microsystems; IBM; Qwest; Oracle; Compaq; Storage Tek; and Intel.

Management and Oversight: The PACI Partnerships are funded through cooperative agreements that define their responsibilities. The Partnerships are expected to manage their own operations and resources

with oversight provided by the NSF PACI Program Officer (CISE). Each Partnership is required to have an Executive Committee, an External Visiting Committee, a User Advisory Committee, and a Resource Allocation Committee. A National Resource Allocation Committee meets semi-annually to review and make recommendations on large resource requests. Enabling Technology and Application Technology Teams that receive funding through the Partnerships must submit annual Statements of Work and quarterly progress reports. The Partnerships submit annual reports and program plans that are reviewed by a Program Review Panel comprised of experts external to NSF. Recommendations of the Program Review Panel and recommended actions are acted upon by the NSF program officer and reviewed by the Division Director. The PACI program had a Committee of Visitors review in 2002, which found the program to be very well managed. PACI was also reviewed in 2001-2002 by an external advisory committee which also found it to be successful and made suggestions for changes consistent with a new vision of cyberinfrastructure.

Current Project Status: FY 2002 marked the last year of the 5-year PACI cooperative agreements. An Advisory Committee on Cyberinfrastructure was chartered in April 2001 and charged with: 1) evaluating the performance of the PACI Program in meeting the needs of the scientific research and engineering community; 2) recommending new areas of emphasis for the NSF Computer and Information Science and Engineering Activity that will respond to the future needs of this community; and 3) recommending an implementation plan to enact any changes anticipated in the recommendations for new areas of emphasis. A one-year extension was approved by the National Science Board to allow the NSF to study the recommendations of the Advisory Committee and formulate a follow-up to the current program. Contingent on the recommendation of the Advisory Committee on Cyberinfrastructure, NSF anticipates modifying and extending the cooperative agreement for a period of 1 to 4 years. The FY 2004 Request for PACI totals $76.49 million, an increase of $5.0 over the FY 2003 Request of $71.49 million. This increase will support increased operations costs, small projects that often support outreach and training, and additional costs the PACI sites incur as part of working with the Pittsburgh-based Terascale Computing System.

Funding Profile: All funds for the operations and maintenance of PACI to date have been provided through the R&RA Account.

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 Req	$25.00	$46.49	71.49
FY 2004 Req	$25.00	$51.49	76.49

NOTE: The current cooperative agreement expired in FY 2002 and was extended until FY 2003 (see below). Estimates for FY 2005 and beyond will be dependent upon a new cooperative agreement.

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

- Concept/Development: Concept planning for PACI was done in the 1995-1997 time frame. The Advisory Committee for Cyberinfrastructure, whose report is anticipated in FY 2003, is expected to suggest some revisions to the program.

- Implementation: Implementation of the PACI facility included initial development of supercomputing facilities and includes continued upgrades to those facilities to maintain the highest performance computing possible. The Partnerships use 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 up to the current state-of-the-art. These funds provide a continual technology refreshment for existing resources which currently have a useful lifetime of approximately three years.

- Operations and Maintenance: The Operations and Maintenance data 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 are to develop technologies that facilitate the efficient use of the computational resources provided by the program. Funding for FY 2004 and beyond is dependent upon the recommendations of the Advisory Committee on Cyberinfrastructure.

Renewal or Termination: The current cooperative agreement expired in FY 2002 and was extended with approval by the National Science Board for one additional year. Contingent on the recommendation of the Advisory Committee on Cyberinfrastructure, NSF anticipates modifying and extending the cooperative agreement for a period of 1 to 4 years, and funding levels for FY 2005 and beyond will be negotiated at that time.

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). The base funding for the EOT-PACI component amounts to approximately 5 percent of the fund for the two PACI cooperative agreements. The EOT-PACI leadership team is comprised of members from both the NPACI and the Alliance Partnerships. The funds they receive through the PACI Program are highly leveraged through donations from private foundations and through NSF funding from EHR and other programs within the NSF. They have 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.

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

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 include a Girl Scout outreach program in the San Diego area.

Science Support: The PACI Program provides access to leading-edge computational resources for all areas of scientific and engineering research supported by the NSF. Percent usage of resources by NSF Directorate Activity are shown in the following table:

Resource Usage, by NSF Directorate

NSF Activity	Percentage of Users[1]	Percentage of Usage
BIO	7%	17%
CISE	23%	11%
ENG	10%	7%
GEO	12%	6%
MPS	27%	55%
SBE	10%	4%

[1]Totals do not add to 100%, as the remaining 11% of users are center staff and industrial participants.

It is estimated that the average annual support of the research groups using these facilities is in excess of $200 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. The net support for these projects is thus estimated to be $200 million per year.

The PACI Partnership Program is a highly leveraged activity with cost sharing contributions from State Government, University, Private Foundations, and Industrial Vendors. From FY 1998-2000 the base support provided through the NSF PACI Program is approximately $200 million and, was matched by a total of $142 million from these other sources.

Other Facilities

Other Facilities support includes continued support for the National Nanofabrication Users Network (NNUN), an integrated network of nanofabrication user facilities at Cornell University, Stanford University, Howard University, Pennsylvania State University, and University of California at Santa Barbara. NNUN itself ends in FY 2003, with the expanded National Nanotechnology Infrastructure Network beginning in FY 2004. Support for NNIN in FY 2004 totals $11.70 million, an increase of $5.50 million over the FY 2003 funding of NNUN of $6.20 million.

Other items within this category include facilities for computational sciences, physics, materials research, ocean sciences, atmospheric sciences, and earth sciences.

OTHER TOOLS

Advanced Networking Infrastructure (ANI)

Advanced Networking Infrastructure (ANI) 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. The very high performance Backbone Network Service (vBNS), now ending its three-year, no-cost extension phase, together with the high performance connections program, have led to the development of a new level of networking for the nation's research universities, including the UCAID/Internet2 operated network Abilene. ANI participates, through focused efforts such as the Network Middleware program, in

accelerating the development and deployment of new technologies in the university-led Internet2 effort jointly supported by the participating universities and the private sector. In FY 2003, ANI will begin programs in Experimental Infrastructure Networks and in Network Research Testbeds. NSF's FY 2004 support for ANI facilities is $46.42 million, a decrease of $200,000 from the FY 2003 Request of $46.62 million.

Cyberinfrastructure

A cyberinfrastructure focus will begin in FY 2004 with requested funding of $20.0 million. Cyberinfrastructure will link computational and data resources (building on experience being gained with Terascale computing efforts) with sensors and instruments, advanced software and middleware to enable distributed systems and analysis, and visualization resources and facilities to promote understanding of science and engineering applications. The promise and demand for cyberinfrastructure has been articulated in a draft NSB report on "Science and Engineering Infrastructure for the 21st Century: the Role of the National Science Foundation." (NSB-02-190). An upcoming report from an NSF Advisory Committee will also provide recommendations. The needs and opportunities in cyberinfrastructure are great at this time, due to rapidly increasing volumes of data generated by scientific instruments and sensors, the increasing capability (with decreasing costs) of computing, networking and sensors, and the demonstration in all fields of the potential for revolutionizing science and engineering.

Major Research Instrumentation (MRI)

The Major Research Instrumentation program is designed to improve the condition of 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 2004, NSF requests $90.0 million, an increase of $36.0 million from the FY 2003 Request of $54.0 million, for continued support of the acquisition and development of research instrumentation for academic institutions. A significant portion of the increase will focus 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 High Field Mass Spectrometry Facility

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.

National STEM Education Digital Library

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 2004 totals $23.80 million, a decrease of $3.70 million from the FY 2003 Request of $27.50 million

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 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 $97.07 million for Polar Logistics, an increase of $3.0 million over the FY 2003 Request of $94.07 million. This increase in Arctic Logistics support will provide for up to 30 additional projects throughout the Arctic including Alaska, Canada, the Arctic Ocean, Greenland, Scandinavia and Russia; modest upgrades at Toolik Field Station, University of Alaska, Fairbanks' field station for ecological research on Alaska's North Slope; begin 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. Support provided by DoD for the U.S. Antarctic Logistics program is level in FY 2004, at $68.07 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. These various resources provide the essential platforms and tools for effective research in all areas of science and engineering. In FY 2004, funding for Research Resources totals $128.85 million, an increase of $22.49 million over the FY 2003 Request of $106.36 million.

Science Resources Statistics

Science Resources Statistics 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 Science Resources Statistics Subactivity includes the education and employment of scientists and engineers and the performance and financial support of research and development. NSF is requesting an additional $1.11 million over the FY 2003 Request of $23.36 million, to a total of $24.47 million in FY 2004. Funding enables NSF to fulfill its statutory mandate to produce data and analysis on the scientific and engineering enterprise, and provides funds to support survey redesign activities and quality improvement projects.

Science and Technology Policy Institute

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 2004, level with support requested in FY 2003.

FY 2004 PERFORMANCE GOAL FOR TOOLS

The following table summarizes NSF's FY 2004 Performance Goal for TOOLS. For additional information, see the FY 2004 Performance Plan.

STRATEGIC OUTCOME GOAL	NO. ANNUAL PERFORMANCE GOAL[A]	FY 2004 AREAS OF EMPHASIS	
		PROSPECTIVE REPORTING: INVESTMENTS IN EMERGING OPPORTUNITIES	RETROSPECTIVE REPORTING, AS RELEVANT
TOOLS **Providing "broadly accessible, state-of-the-art and shared research and education tools."**	III-2 ***NSF's performance for the TOOLS Strategic Outcome is successful when, in the aggregate, results reported in the period demonstrate significant achievement in the majority of the following indicators:*** • Development or provision of tools[D] that enables discoveries or enhances productivity of NSF research or education communities; • Partnerships with local, state or federal agencies, national laboratories, industry or other nations to support and enable development of large facilities or other infrastructure; • Development or implementation of other notable approaches or new paradigms[E] that promote progress toward the TOOLS outcome goal.	❑ Major Research Equipment and Facilities Construction (MREFC) ❑ Cyberinfrastructure ❑ Science Resources Statistics (SRS) Survey Redesign	❑ Major Research Equipment and Facilities Construction (MREFC) ❑ Major Research Instrumentation (MRI) Program ❑ Science and Engineering policy analyses, information, reports and databases ❑ Scientific databases and tools for using them, including the National STEM Education Digital Library

A This performance goal is stated in the alternate form provided for in GPRA legislation.

D For example, includes research and education infrastructure such as large centralized facilities, or integrated systems of leading-edge instruments, or databases, or widely utilized, innovative computational models or algorithms, or information that provides the basis for a shared-use networked facility.

E For example, broad-based, program-wide results that demonstrate success related to management/utilization of large data sets/information bases, or development of information and policy analyses, or use of the Internet to make STEM information available to NSF research or education communities, or exceptional examples of broadly accessible tools shared by NSF research and education communities.

Highlights of Recent Accomplishments - Tools

Advanced Research Computing System (ARCS). Atmospheric scientists now have access to powerful new computational, storage, and communications technologies provided by the National Center for Atmospheric Research (NCAR) with the purchase of a new IBM SP supercomputer, code-named Blue Sky, to be followed by the latest-generation technologies, in a three-phase acquisition. The new system is expected to accelerate research in global and regional climate change, droughts, short- and long-range weather prediction and warnings, wildland fires, turbulence, atmospheric chemistry, space weather, and other critical areas. The addition of Blue Sky to NCAR's computing center is the single biggest increment in raw computing power in NCAR history. ARCS will provide U.S. scientists with the speed, efficiency, and data storage space they need to stay at the forefront of research in climate, weather, and many other essential areas. The center provides supercomputing power, as well as observing facilities, to atmospheric researchers at universities around the nation.

Robotic undersea exploration. The Autonomous Benthic Explorer (ABE), the first vehicle of its kind, was developed because of scientists' frequent need to monitor an area over long periods of time, which is very expensive using a surface ship with submersibles such as Alvin. ABE is a true robot, able to move on its own with no pilot or tether to a ship, designed to perform a predetermined set of maneuvers to take photographs and collect data and samples within an area about the size of a city block. It will then "go back to sleep," conserving power to enable months of repeating these tasks. Its developers envision that in the future underwater acoustic transmission systems now being developed will allow scientists anywhere in the world to receive video and data from ABE and to control its movement and measurements from their home laboratories.

Telemedicine technology at the South Pole. A meteorologist wintering over at the South Pole underwent successful knee surgery with the help of a telemedicine link between the South Pole and doctors at Massachusetts General Hospital. The physician at the South Pole, assisted by an orthopedic surgeon and an anesthesiologist in Boston, Massachusetts, carried out the operation. Two-way voice and video links between the U.S. and Antarctica have been used to assist in medical procedures before, but this is the first time that telemedicine has been used for surgery.

Completion of the Pegasus runway. This past season a compacted snow/ice runway was created at McMurdo Station, Antarctica that is capable of supporting all types of wheeled transport aircraft. This development enables large, wheeled aircraft to operate season long between Christchurch, New Zealand, and McMurdo Station, thereby freeing up the ski-equipped LC-130's to maximize the numbers of intra-continental flights devoted to Antarctic science or construction. The runway also provides the opportunity to extend the science season.

Improved infrastructure for support of Arctic science. NSF continued to improve infrastructure for Arctic science at Toolik Lake field station, including completing improvements to the kitchen, bathroom and sleeping facilities, and improving the internal laboratory layout. Toolik now accommodates up to 100 scientists during the peak summer months, double the capacity of just three years ago.

Continual queries. NSF-supported investigators have introduced the concept of Continual Queries (CQ) and have developed techniques that monitor events and notify the user of changes whenever updates of interest happen. This system has been used by the National Cancer Institute to track cancer clinical trial information over a dozen information sources. It helps cancer researchers, patients, friends, and relatives track new treatments and new cancer trials of interest. This research has led to the current wide interest in data stream research technologies. Application areas include logistics and unified access to about 500 biological databases.

Assessment of children's attention. Accurate assessment of children's attention is essential for continued examination of the role of attention in the development of skills such as literacy and numeracy as well as examination of the neurological substrates of attention. NSF-supported scientists have developed the Attention Network Task (http://www.sacklerinstitute.org/), a database to reliably assess orienting and alerting aspects of attention in children. The Attention Network Task is being used to track an attention-oriented literacy-training program that is showing initial promise in the laboratory and in public school settings. As well, they are also using this task to link genetic, electroencephalograms (EEG), and functional magnetic resonance imaging (fMRI) findings to attentional behavior. Other researchers have begun to use the Attention Network Task to study Attention Deficit Hyperactivity Disorder (ADHD), autism, child abuse, and other conditions that might affect attentional functioning.

National High Magnetic Field Laboratory (NHMFL). The National High Magnetic Field Laboratory provides the highest continuous magnetic fields in the world, including the only magnet system in the world providing a 45 tesla steady field. The 45-T magnet is available as a user facility for basic research. It provides unique opportunities to users from the U.S. and worldwide for groundbreaking research in a variety of disciplines ranging from condensed matter physics to materials science, chemistry, biology and engineering. Many of the technologies used in developing the high field magnet systems at the NHMFL have been developed in collaboration with private industry. The NHMFL is supported in partnership by NSF and the State of Florida, and is operated cooperatively by Florida State University, the University of Florida, and the Department of Energy's Los Alamos National Laboratory.

Dive and Discover. "Dive and Discover" is an interactive distance learning Web site designed to immerse students in the excitement of discovery and exploration of the deep seafloor. Six expeditions to the seafloor have been completed. The most recent expedition was an exploration of the Galápagos Rift hydrothermal vents that commemorated the discovery of the first hydrothermal vent communities 25 years ago. The Dive and Discover web site (http://www.divediscover.whoi.edu) contains information intended for both teachers and students. Daily updates, slide shows, videos, and e-mail correspondence with scientists aboard research vessels allow students to follow the progress of the scientific mission and get a taste of life aboard a research vessel. The Educator's Companion portion of the site gives teachers access to classroom integration tips including background information, interactive learning modules, and assessment tools.

The Panel Study of Income Dynamics (PSID). The PSID meets NSF's strategic performance goal "to provide broadly accessible, state-of-the-art and shared research and education tools." With thirty-plus years of data on the same families, the PSID can be considered a cornerstone of the infrastructure support for empirically-based social science research. The PSID is a longitudinal survey initiated in 1968 of a nationally representative sample for U.S. individuals and the family units in which they reside. The major objective of the panel is to provide shared-use databases, research platforms and educational tools on cyclical, intergenerational and life-course measures of economic and social behavior. PSID has been central to the fundamental understanding of key social science issues with substantial broad impacts on society: income, poverty and wealth; cyclical behavior of wages, labor supply and consumption; savings, wealth accumulation and transfers; demographic events (teen childbearing, marriage, divorce, living arrangements, mortality); labor market behavior; and the effects of neighborhoods. PSID data are being used to assess current government policies such as the impact of welfare reform on low-income, African-American and Hispanic families. A consortium of government agencies supports PSID, including NSF, NIA, HHS, HUD and USDA. http://www.isr.umich.edu/src/psid/

Dissemination of information by Federal agencies while protecting confidentiality. NSF support has enabled development of computer algorithms that use geographical aggregation to disseminate, as nearly as possible at the county level, data that previously were disseminated only at the state level. The algorithms also allow characterization of inferences drawn from the released information. Systems were

built to implement geographical aggregation in real time, producing maps and other forms of output that disseminate information safely and in unprecedented detail. The Web-based system for geographical aggregation, with its powerful graphical user interface, is usable by sophisticated researchers and by citizens with less technical training. The project is developing an entirely new paradigm for disseminating information derived from confidential data, balancing the utility of the released information against disclosure risk.

Water resources. The NSF Science and Technology Center for Sustainability of semi-Arid Hydrology and Riparian Areas (SAHRA) provides scientists from many different disciplines an opportunity to engage in field research that addresses fundamental water resource questions. Desert streams provide aesthetic, environmental, and economic resources. Questions being investigated include how changing land uses, droughts, fire management policies, and other factors have affected vegetation in the semi-arid Southwest and how vegetation changes impact surface water runoff and recharge of groundwater aquifers.

Science research assists the Joint Strike Force Fighter program. As an example of basic science research yielding unforeseen benefits, the Joint Strike Force Fighter program is reaping rewards from the NSF investment in the Laser Interferometer Gravitational-wave Observatory (LIGO) facility. Designed to hunt for gravity waves (a fundamental physics concept championed by Albert Einstein), LIGO's lasers need to be extremely precise. NSF-supported Stanford researcher Robert Byer loaned one of the LIGO technologies for refining laser light to General Electric, which uses lasers to detect defects in the body panels of the Joint Strike Fighter. The laser technology reduced the amount of time required for some of the aircraft's inspection process by a factor of ten, resulting in a substantial cost savings in manufacturing this next-generation fighter.

Administration and Management

The National Science Foundation's (NSF) leadership in advancing the frontiers of science and engineering research and education is made possible by its commitment to excellence in Administration and Management (A&M). The agency has a solid history of leveraging its expert, motivated workforce, its mission-essential management processes, and its state-of-the-art technological resources to promote the progress of science and engineering through investments in *People, Ideas,* and *Tools*.

The Request is built around the strategic goals identified in the NSF Strategic Plan for A&M:

- Human Capital: A diverse, agile, results-oriented cadre of NSF staff committed to supporting the agency's mission and to expanding their abilities constantly to shape the agency's future.

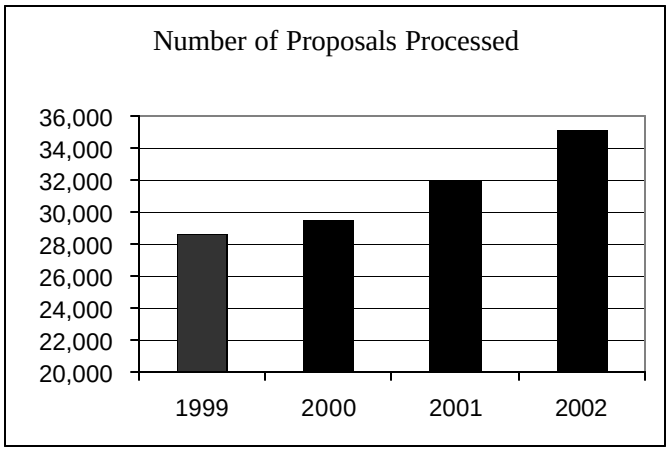
- Business Processes: Effective, efficient, strategically aligned business processes that integrate, capitalize on and are shaped by the agency's human capital and technology resources.

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

These goals provide the framework for the proposed FY 2004 investments in A&M. The budget is built around two principal investments, **Human Capital** and **Technologies and Tools**, which in turn enable NSF's Business Processes.

There is a direct correlation between the growth of the core mission and the amount of funding needed to support operations that achieve the mission. Historically, as NSF programmatic budgets have increased, the A&M budget has not kept pace proportionately, thus straining the ability to maintain high service levels. Special budgetary attention to operations is essential in FY 2004 in order to support recent and future advancements adequately.

In FY 2002, the number of proposals processed at NSF rose to over 35,000, a 10 percent increase over FY 2001. This is the fourth year of significant workload increases. Between FY 1999 and FY 2002 the proposal load increased by nearly 25 percent while staffing increased by less than 4 percent. The NSF workforce has been able to manage this workload increase, in large part, through effective use of technology; however, operational efficiencies through the effective use of information technology alone cannot be relied on to accommodate increases in workload indefinitely.

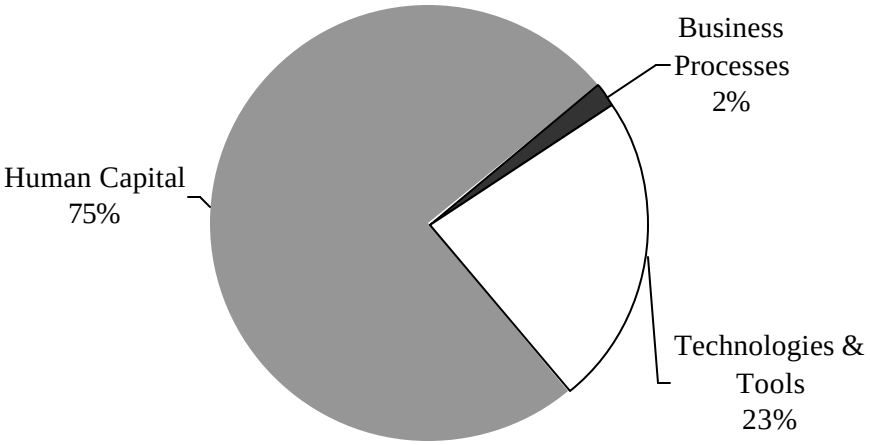


The FY 2004 Request of $291.36 million for A&M, approximately 5.3 percent of the agency's total budget request, represents an increase of $30.79 million, or 11.8 percent, over the FY 2003 Request of $260.57 million.

About two-thirds of the $30.79 million increase supports NSF's investment in Technology and Tools and about one-third of the increase is directed towards Human Capital. The Technology and Tools increase will support a world-class information technology infrastructure and address management challenges identified through various internal and external reviews. The major driver of the increase for human capital investments is funding for 30 Intergovernmental Personnel Act (IPAs) to help manage increased workload.

Overall, for the FY 2004 Budget Request total, 75 percent of A&M is devoted to Human Capital; 23 percent provides resources for Technologies and Tools; and the remaining 2 percent provides resources for the business process analyses being conducted by Booz Allen Hamilton and for the organizational review by the National Academy of Public Administration.

FY 2004 A&M Budget Request by Strategic Goal



Summary of Administration and Management by Function
(Dollars in Millions)

	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	Change Amount	Change Percent
Human Capital					
Personnel Compensation & Benefits	121.28	132.43	133.68	1.25	0.9%
IPA and Program Support (including Travel)	53.95	49.92	56.89	6.97	14.0%
Management of Human Capital	1.65	3.79	4.83	1.04	27.4%
Operating Expenses	4.31	6.51	6.74	0.23	3.5%
Travel - Employee	4.59	5.73	6.11	0.38	6.6%
Subtotal, Human Capital	185.78	198.38	208.25	9.87	5.0%
Business Processes	0.45	4.00	4.50	0.50	12.5%
Technology and Tools					
Space Rental	16.31	17.49	18.65	1.16	6.6%
Other Infrastructure	4.95	7.81	8.46	0.65	8.3%
Information Technology	16.39	25.19	42.73	17.54	69.6%
Subtotal, Technology and Tools	$37.65	$50.49	$69.84	$19.35	38.3%
Office of the Inspector General	$6.70	$7.70	$8.77	1.07	13.9%
Total	$230.58	$260.57	$291.36	$30.79	11.8%
FTE					
Staff -- NSF[1]	1,188	1,217	1,200	-17	-1.4%
Staff -- OIG	51	53	60	7	13.2%
Arctic Research Commission	4	4	4	0	0.0%
IPA	129	140	170	30	21.4%
Detailees to NSF	6	5	5	0	0.0%
Contractors Performing Admn. Functions	175	210	210	0	0.0%
Total, Workforce	1,553	1,629	1,649	20	1.2%

[1]The 17 FTE reduction in NSF staff in FY 2004 is due to employees from programs proposed for transfer to NSF from other agencies in the FY 2003 Request, which are not proposed for transfer in FY 2004.

HUMAN CAPITAL

Personnel Compensation and Benefits

Resources in the Personnel Compensation and Benefits (PC&B) category provide funding for salaries and benefits of federal employees, career ladder promotions, and bonuses. These costs are projected to increase from $132.43 million in FY 2003, by $1.25 million, to $133.68 million in FY 2004. The FY 2004 Request totaling $133.68 million will fund 1,200 full-time equivalents (FTE). The small reduction in the NSF staff from 1,217 in FY 2003 to 1,200 in FY 2004 is due to the employees associated with the programs that were proposed for transfer to NSF in the FY 2003 Request. The base NSF staffing level will remain constant between FY 2003 and FY 2004.

IPA and Program Support

The FY 2004 Request for IPA and Program Support (i.e., administrative activities) funded through programmatic accounts increases by $6.97 million totaling $56.89 million. This funds 170 IPAs through grants to institutions for temporary assignments, associated costs for IPA travel and equipment, and

contracts for programmatic-related services. The increase in IPAs is needed to process and help manage the additional workload associated with the increase in proposals.

Management of Human Capital

The FY 2004 Request for Management of Human Capital is $4.83 million. NSF's approach to strategic management of human capital seeks to ensure that the agency has the *right people with the right competencies in the right jobs at the right time*. NSF's approach to workforce and succession planning encompasses both the development of critical talent and core competencies from within, and the identification and recruitment of strategic talent from outside the agency. This two-pronged approach, together with the business analysis, will allow the agency to anticipate and meet its staffing needs in the challenging, dynamic environment that constitutes work at the science and engineering research and education frontiers and ensures that employees are well prepared to meet agency challenges in the near- and longer-terms.

NSF has a long history of drawing upon its current hiring flexibilities to attract a cadre of temporary scientists and engineers who are leaders in their respective fields and who join the agency for periods of one to three years. Through these flexibilities, NSF engages scientists and engineers who bring new perspectives to motivate agency innovation and stimulate investments that might not otherwise occur.

NSF has also made strategic learning and career development a key focus of its long-range human capital plan. In FY 2002, NSF formally established the NSF Academy. The Academy will place the agency at the forefront of both the public and private sectors through its vision of the full integration of life-long learning and career management into the daily work lives of its employees.

Although NSF continuously strives to identify and address strategic human capital needs, the Foundation recognizes that it must make significant investments in human resource initiatives to retain and enhance its position as an employer of choice, particularly with its academic and scientific constituencies. Additionally, with ongoing implementation of technological improvements, advances in science, cross integration of scientific initiatives, and an emphasis on strategic use of limited resources, NSF must continuously upgrade the skills of its business and administrative staff.

NSF's FY 2004 human capital budget will situate the agency to aggressively pursue top talent across scientific and engineering disciplines through the implementation of best practice human resource recruitment, retention, performance and award, and development programs. It will also provide needed impetus in NSF's efforts to address the potential crisis in human capital that has been recognized by both the General Accounting Office and the Office of Management and Budget as a major management challenge for all Federal agencies in the foreseeable future. The FY 2004 Human Capital request includes an increase of $1.04 million to maintain services ($127,000) including those offered through the Academy and to address recommendations stemming from the business analysis ($913,000), as described below.

Implementation of Strategic Human Capital Initiatives ($913,000)

By the end of FY 2003, the business analysis will result in a comprehensive human capital plan that will serve as a strategic tool for the agency to optimize the performance of its workforce. The plan will provide a competency model that will serve as the foundation of a comprehensive, integrated human capital system to include recruitment, retention, classification and pay, automation tools, human resource accountability, and performance management and rewards.

- **Occupation Classification Management ($219,000):** A competency-based Occupation Classification Management process will be implemented to help ensure that NSF has appropriately identified and organized functions into meaningful and effective job relationships focused on current and future skill needs. Competencies will be directly linked to the classification system and, therefore, the pay system. Jobs will be grouped into new families based on competency profiles and will identify career progression opportunities for employees. NSF will work closely with the Office of Personnel Management to effect a smooth transition from previous to new positions and pay plans, and will implement necessary transition processes to guide employees into new endeavors.

- **Recruitment and Retention Enhancements ($219,000)**: Informed by the new occupation classification process, NSF will undertake a comprehensive assessment of recruitment and retention practices and implement forward-looking revisions that will enhance NSF's ability to attract scientists and engineers at the forefront of their professions to work for the Foundation. Similarly, recruitment and retention of high quality business and operations professionals will be addressed.

- **Performance Management and Awards ($219,000)**: The new performance management and awards methodology will link performance appraisals to the new competency models, including performance expectations for each competency. It will incorporate recognized best practices to ensure that the agency rewards high performers and addresses low performers and will be designed to minimize administrative burden.

- **Human Resource Management (HRM) Accountability ($256,000)**: The President's Management Agenda initiative on human capital specifically requires that agencies establish meaningful human resource accountability processes to ensure that management officials and human resource service providers are effectively managing their resources and are in compliance with merit system principles. Building on prior successful efforts, NSF will establish links between existing measures of accountability as well as establish appropriate new measures to have the capability to assess the effectiveness of its programs and its leadership resources.

NSF Academy ($2.30 million)

In order to fulfill its mission, NSF must cultivate a world-class staff by providing them with the knowledge and tools necessary to sustain a high level of excellence. The Academy is the central focus of learning for NSF. It will provide a comprehensive array of learning experiences that are curriculum-based and strategically aligned with the mission of the agency. These programs will emphasize cross-functional learning in order to enhance individual, team, and organizational performance and provide federal service career paths for each individual. Academy programs will provide the basis for the continual learning environment that is central to NSF's values. The Academy's emphasis on excellence, sharing of ideas, information and opportunities, integrity, breadth of knowledge; and flexibility will encourage those values in all employees.

The Academy made significant strides toward the goal of building a learning culture within NSF in FY 2002, particularly in an environment that serves three distinct internal populations: science and engineering; business and operations; and program support staff. In order to provide inclusive learning opportunities for all NSF staff, several new learning venues were created. These venues include the successful launch of an eLearning pilot, which is now fully operational, and the implementation of five eBusiness tutorials. Additionally, NSF is continually benchmarking other corporate universities, and exploring partnership opportunities with other learning institutions to enhance and grow our curriculum.

In addition to curriculum development, in FY 2003 the Academy efforts are focused on Academy governance. The Foundation will transition to the new Academy -- establishing an external Academy Advisory committee and recruiting a dean. Finding the right combination of leadership is critical to the success of the Academy.

The Academy will remain at approximately $2.30 million in FY 2004 the same as in the FY 2003 Request. While resources are relatively constant, the Academy's efforts will continue to support innovative ways to train and educate our staff. Within these resources we will assess learning models to discover the most innovative ways to cultivate a world-class staff.

In subsequent years, once the Academy governance and curriculum is more fully developed, the following areas will require more focus:

- Leadership and Executive Competencies
- Career Management
- NSF Employee Orientation
- Curriculum Based Classes
- University/College Partnerships and Corporate University Development
- Technology Learning Investments
- Strategic Development Initiatives
- Academy Assessment and Evaluation Tools
- Learning Resource Advancements
- Project Management

Operating Expenses

Operating Expenses increase $230,000 to $6.74 million in FY 2004. This includes funding for direct costs of the FTE staff, for supplies, equipment, and other operating expenses necessary for the management of NSF's research and education activities.

Travel

Travel increases by $380,000 to $6.11 million in FY 2004 and provides funds for FTE staff in the S&E appropriation. These resources are sufficient to fund costs associated with a reliable merit review process and the award oversight recommended by the agency's Inspector General. These funds will also be used to intensify oversight activities; participate in national and international science and engineering conferences and workshops; and seek strategic training opportunities.

BUSINESS PROCESSES

NSF's Business Analysis ($4.50 million)

Beginning in FY 2002, NSF initiated a comprehensive, multi-year Business Analysis, the outcomes of which will inform A&M investments for the foreseeable future. The Business Analysis will:

- Document each of the agency's core *Business Processes* and define its contribution to the NSF mission.
- Define process effectiveness and efficiency improvements that leverage past experiences, capitalize on best practices in the public and private sectors, and respond to emerging mission-related trends.
- Develop future-looking *Business Process* scenarios and criteria for success.
- Define a *Human Capital Management Plan* to provide next-generation human capital capabilities. The plan will identify future-looking workforce competencies and describe human capital strategies and approaches to support the *Business Process* scenarios and to capitalize on opportunities afforded by *Technologies and Tools* innovations.
- Define an *Integrated Technologies and Tools Plan* (business infrastructure tools, knowledge bases, and technologies) that describes an overall integrated technical and information architecture for future systems and capabilities in support of the agency's *Business Processes*.

The following mission-focused core *Business Processes* define how the agency delivers value to scientists, engineers, educators and to the nation, and form the framework for the analysis:

- *Resource Allocation: setting the right priorities…*
    - A resource management process that incorporates performance results and other inputs to prioritize agency programmatic and management investments across organizational levels, resulting in optimal administration of a balanced, performance-based portfolio.

- *Merit Review: identifying people, ideas and tools with the greatest potential for impact…*
    - A fair, competitive, transparent merit review process for selecting projects, managed in the context of priorities, and through which the agency realizes its outcome goals.

- *Award Management and Oversight: the award cycle, beginning to end…*
    - A collaborative, multi-functional award management and oversight process that (1) is informed by appropriate risk management strategies, (2) ensures performance outcomes are appropriately identified, (3) optimizes connections between discovery, learning, innovation and widespread practice through effective evaluation and communication, and (4) verifies that projects are in compliance with award agreements and federal regulations.

- *Knowledge Management: developing and sharing new knowledge in a timely and effective manner…*
    - A comprehensive set of information management and communications activities that capture, synthesize and share new knowledge generated by NSF and NSF investments – in order to provide the agency's managers and many stakeholders with reliable, timely and accessible information about agency priorities and opportunities, and resulting science and engineering outcomes and contributions.

- *Performance Assessment and Accountability: the highest standards of excellence and integrity…*
    - A thorough performance assessment and accountability process that develops and measures effective performance indicators and ensures the agency is held accountable for meeting its mission and goals.

The outcome of NSF's Business Analysis is an A&M and investment strategy focused on quality, efficiency, agility, and flexibility and designed to realize the agency's *Human Capital, Business Processes* and *Technologies and Tools* goals.

National Academy of Public Administration Review

NAPA will conduct a review of NSF's organizational, programmatic, and personnel structures to assure that the agency is positioned to maximize scientific opportunities. This review is consistent with the Congressional guidance provided in House Report 107-740. Specific topics to be addressed in the review include: organizational and program structure; establishment of investment priorities; personnel policies, especially those related to temporary appointments; and the role of the National Science Board. This review will cost on the order of $1 million, distributed about evenly between FY 2003 and FY 2004.

TECHNOLOGIES AND TOOLS

For more than 50 years, NSF's high-performing workforce has enabled discovery, learning, and innovation across the science and engineering frontier in research and in education. New customer-focused eGovernment capabilities have significantly improved the agency's ability to solicit, review, select, award, manage and report results on government-funded research and education projects. The agency's paper-based work processes have been replaced and shaped by technology-enabled ways of doing business thereby capitalizing on the latest technological capabilities, improving efficiency, and enabling NSF, to serve as an effective and capable steward of the taxpayer's resources. NSF is a true eGovernment success story. As a result of the technology innovations implemented by NSF, in FY 2002 NSF received and processed electronically more than:

- 35,000 Proposals (over 99 percent of all proposal received)
- 150,000 Reviews
- 6,000 Graduate Research Fellowship applications
- 22,000 Grantee Progress Reports
- 8,000 Post-Award Actions
- 14,000 Cash Requests
- $4.0 Billion in Fund Distribution Requests

In addition to these results, NSF's return on investment has yielded improvements in both effectiveness and efficiency. For example, in FY 2002, technology investments helped NSF achieve its goal of processing 70 percent of proposals within six months. What is even more remarkable is that since FY 2000, the number of proposals processed has increased with very little increase in staffing. In addition, through new electronic panel review processes, NSF significantly reduced processing time and improved the quality of the merit review process for NSF panelists. Enhancements to the award-winning FastLane and FastLane Help Desk have continued to improve the grant application and award process for proposal applicants. With the FastLane system, NSF reduced its proposal handling costs significantly, despite a 10 percent increase in proposals processed and a 19 percent increase in applications for graduate fellowships and a 10 percent increase in proposals processed. As an indication of the dramatic effect the system has had on reducing paper-based transactions, in 2002 alone, NSF reduced its paper and supply costs by 26 percent and its postage costs by 44 percent.

NSF's focus on demonstrating management excellence is sharpened through attention to specific issues. For example, the President's Management Agenda (PMA) mandates that NSF, like other agencies, demonstrate consistent results through proven management practices. While much has been accomplished and a strong foundation for success is in place, NSF's plans for FY 2004 and beyond must respond to new challenges and needs such as:

- Remaining at the cutting edge of innovation and discovery
- Sustaining a knowledge-rich, world class workforce
- Supporting eGovernment mandates
- Delivering technology-enabled business process improvements
- Replacing a rapidly aging infrastructure
- Enhancing physical and cyber security

The *Technology and Tools* portion of NSF's FY 2004 Administration and Management Request addresses critical investments needed to respond to key President's Management Agenda (PMA) initiatives, support a world-class infrastructure, and meet management challenges identified through internal review and oversight as well as those identified by our partners, including the agency's Inspector General, committees of experts representing the science, engineering and education community, and the General Accounting Office. To assure continued linkage with NSF goals and key PMA initiatives, the Technology and Tools Budget Request includes the following investments:

Enabling Human Capital Management ($1.0 Million)

In order to achieve NSF's goal of sustaining a world-class, knowledge-rich workforce, technology investments are critically needed to replace aging, legacy applications that were designed to support 1980s personnel processing needs. eHuman Capital is an integrated technology solution set to address nearly all aspects of Human Capital related requirements, including: recruitment, classification and staffing processes; eLearning technologies to achieve NSF Academy goals and support a continuous learning workforce; and related time and attendance and benefits services. Included in Human Capital initiatives are activities to plan for, select, and transition to a new government-wide mandated payroll system. As part of our payroll migration effort, NSF is evaluating government-wide HR solutions providers so that NSF can leverage best-in-class provider options for human resources as well as payroll services.

Accurate, timely human capital information is essential for effective planning and management of NSF's workforce. A fully integrated system will provide simple, easy to use, cost effective, standardized, and integrated eHuman resources and payroll services to support NSF's mission and to help it plan for future needs. This solution will transform the current human resources and payroll service delivery environment into one that achieves PMA initiatives and is consistent with government-wide eGov initiatives in human resources and payroll.

During FY 2003, NSF will initiate definition of requirements and business processes for the end-to-end human capital system, including selection and migration planning for transition to the new government-wide mandated payroll system and other government-wide human resources initiatives. During FY 2004, NSF plans to complete requirements analysis, evaluate alternatives, including government-wide service providers/solution sets, and begin implementation of high priority capabilities.

Continued Leadership and Innovation in eGovernment ($4.40 million)

NSF is a partner in four eGovernment initiatives: eGrants (led by the Department of Health and Human Services), ePayroll, the Enterprise Human Resources Integration (EHRI) initiative (both, led by the Office of Personnel Management), and eTravel (led by the General Services Administration). NSF continues to support all other endorsed initiatives to achieve government-wide efficiencies.

NSF is a partner with the government-wide eGrants initiative and works closely with the National Institutes of Health and other federal agencies in the development of electronic systems supporting grants

processes for the science and engineering research and education community. While other agencies plan for electronic grant submission and administration, in October 2000, NSF started conducting virtually all business interactions and transactions electronically with its grantee community through its FastLane system, and continues to lead in delivering innovations through electronic grants processing.

The following investments are planned for FY 2004 to support continued advances:

- **FastLane Enhancements**: FastLane is an interactive real-time system used to conduct core NSF business processes over the Internet. Over 230,000 scientists, educators, technology experts and administrators, including the country's top researchers, use the over 40 FastLane Web-based applications to conduct business electronically with NSF. Planned enhancements are in response to high priority customer requests and changes needed to complement efforts planned for the government-wide eGrants and eTravel.

- **Continued Implementation of Electronic Jacket**: The Electronic Jacket (eJacket) system is the remaining piece required for total electronic proposal processing at NSF. eJacket meets requirements to support internal grants and awards processing. Staff will eventually have the ability to perform most essential internal business functions related to proposal and award processing without paper jackets (i.e., file folders), facilitating the Foundation's ability to reduce paperwork and improve records management. FY 2004 funding supports deployment of critical program officer work functions and integration with legacy applications.

- **Next-Generation eGrants (PRAMIS):** As a result of the Business Analysis work planned for the Merit Review and Awards Management and Oversight processes, NSF will re-engineer its business practices to improve grant monitoring activities and the processing of large and complex awards, and to include a pre-award review functionality. This system will complement government-wide eGrants and service NSF-specific internal grants and awards management processing and information management requirements. The next generation eGrants system (referred to as the Proposal, Review, and Awards Management Information System or PRAMIS) will implement a redesigned business process aimed at transforming the current mix of electronic and paper-based sequential award processing to enable dynamic, simultaneous processing of NSF program announcements, proposals, and awards. PRAMIS is anticipated to integrate the current capabilities of FastLane, Program Information Management System (PIMS), Electronic Jacket, eGrant, and other internal NSF electronic administrative systems as well as integrate with government-wide eGrants. PRAMIS will also provide capability for electronic solicitation, proposal receipt, award and contract administration functions that interface with outside web-based federal eGovernment resources and relevant NSF internal information systems.

- **Continued Support for Government-Wide eGrants**: The government-wide eGrants initiative is defining interfaces and data structures for program announcements and proposal submissions to be adopted by all agencies. Unlike agencies that are just beginning to implement electronic grants, NSF will need to retrofit existing systems to interface and interact with eGrants. This will be a costly effort, as investments will be needed for government-wide system integration requirements.

The Human Capital and eGovernment initiatives will enable NSF to address key components of the President's Management Agenda including:

Improved Financial Management: During FY 2004, initial planning efforts to enhance technology support for improved financial management include the following activities:

- Through the eHuman Capital initiative, requirements to transition to a new OPM-led government-wide payroll system and to provide continued support to the government-wide Enterprise Human Resources Integration initiative will be addressed. This will include activities to select the new service provider, define an orderly migration strategy from NSF's current payroll system, and establish necessary interfaces with core financial systems.

- Through the Next Generation eGrants (PRAMIS) initiative, business process innovations to ensure prompt, reliable and valid payments and pre- and post-award grant monitoring will be implemented, and contract management activities will be deployed.

In support of the government-wide eGrants, EHRI, ePayroll, and eTravel initiatives, NSF will continue to invest in incremental improvements to the current Financial and Accounting System in FY 2004 and beyond and in the FastLane system. It is not anticipated that a major modernization initiative will be required for the Financial and Accounting System until the FY 2006-08 time frame.

Integrating Budget and Performance

FY 2004 investments to address *Integrating Budget and Performance* are focused on projects that include reporting, trend analysis, GPRA performance assessment, and Committee of Visitors (COV) and advisory committee data services. Inherent in investment plans to address *Integrating Budget and Performance* is the need to develop a strong suite of knowledge bases, derived from various sources, and supplemented by analytic support and executive information system capabilities. The FY 2004 Request includes funding for enhancements to the Enterprise Information System and development of improved, consistent, and readily available data for COVs. Investments in FY 2005 and beyond will focus on the development of key knowledge bases and implementation of recommendations resulting from the NSF Business Analysis and the program framework developed through the ongoing update of the NSF Strategic Plan.

Delivering World Class Customer Services and Secure Infrastructure

The FY 2004 Request includes an increase of $12.10 million to support day-to-day operations of the NSF information technology and physical infrastructure. Adequate funding in these areas is critical to the efficient operations of the agency. While NSF's overall budget has grown, and significant advances have been made through the use of innovative information technology, funding for infrastructure operating expenses has, until the FY 2003 Request, remained essentially flat. Highlights of NSF's plans for infrastructure and operational initiatives include:

- **Continued improvements to NSF's Security Program**. NSF's comprehensive, agency-wide information technology security program encompasses all aspects of information security, including policy and procedures, risk assessments and security plans, managed intrusion detection services, vulnerability assessments, and technical and management security controls. The FY 2004 Request includes key investments needed to sustain and improve NSF's information security program and posture. This includes continued investments to implement a balanced, technology-enabled security program that includes physical and IT security requirements. Included in this investment is the continued deployment of "smart technology" to meet physical and cyber security needs, and expanded penetration testing and vulnerability scanning for defensive measures. This also includes establishing a common, "corporate directory service" that will store and manage user profiles, access privileges, and application and network resource information. This service will help ensure appropriate access policies are followed across NSF applications, facilities, and services.

- **Plans for a Robust Enterprise Architecture to Support Next Generation Capability**. NSF is following a disciplined approach for assuring that new investments are planned and evaluated within the context of an overall Enterprise Architecture framework. Evolving the NSF Enterprise Architecture is a strategic priority for NSF to assure that it is aligned to support changing business practices and associated workforce needs, funding decisions, and technology advances. The NSF Integrated Enterprise Architecture will: (1) provides a blueprint for defining current business processes, applications, information resources, and technical infrastructure; (2) support definition of the knowledge bases, applications, and supporting technology that are needed to support evolving NSF mission needs; and (3) define a crisp transition strategy and plan for achieving an integrated Enterprise Architecture that is consistent with NSF business goals and operational priorities. As changes to *Business Processes* and requirements are made in later phases of the Business Analysis, the Enterprise Architecture and migration strategy will be updated to reflect evolving business and operational priorities.

- **Enhancements and Initiatives to Improve Operational Efficiency.** NSF has developed a multi-year approach to improving the infrastructure and deploying the hardware, software, and tools necessary to manage and operate applications that process approximately $5.0 billion annually. Our multi-year approach to replace aging hardware, software, and enterprise servers, with priority on equipment three years old and older, allows for incremental improvements in the performance, reliability, and security of the operational infrastructure and is consistent with overall government-wide budget constraints. For example, half of network floor servers are more than four years old, and one-third are six years old and older. Until FY 2002, NSF lacked redundancy for mission-critical financial and grants applications or the capability to recover quickly in the event of a server failure. In FY 2002, NSF began a phased approach to acquire and deploy industry standard tools necessary to manage securely the complex information infrastructure. These include software configuration management and testing tools, performance-monitoring tools, and call center software tools to support the tracking of customer service requests. The Request includes funds to continue implementation of critical investments needed in supporting hardware, software, and tools necessary to manage and operate an infrastructure that can support NSF electronic business processes. Increased costs to support and improve the infrastructure and day-to-day services include:

    - Maintenance for FastLane, which is a suite of over 40 web-based applications, used by more than 230,000 scientists, educators, and administrators;
    - Maintenance for legacy information technology applications and the additional costs to maintain new capabilities for the National Science Board, Office of Equal Opportunity, and other administrative functions;
    - Support of government-wide eGovernment initiatives;
    - New integrated contracts to improve the management and efficiency of the NSF data center, help desks, and network management;
    - Maintenance of a balanced security program, operational security, including 24x7 intrusion detection services, internal and external penetration tests, disaster recovery tests, and additional operational security controls;
    - Support the 8,000 (average) customer services calls per month for FastLane and other IT services requests;
    - Corporate software licenses and maintenance fees increased dramatically over the FY 2002 level;
    - Support redundancy and backup for critical services such as major systems production environments, email, and internet access;
    - Implementation and support for tools initially deployed in FY 2002 to improve and manage software lifecycle activities, addressing software engineering standards, program management, quality assurance, testing, and configuration management;

- Administrative services and facilities management.

- **Space Rental**. To relieve crowding in Stafford Place, an additional floor of space is required in an adjoining building. Coupled with the increased costs of existing space, an additional $1.16 million is requested in FY 2004.

THE ADMINISTRATION AND MANAGEMENT PORTFOLIO

The Foundation's Administration and Management activities are funded through four appropriations accounts:

- **Salaries and Expenses** (S&E) increases to $225.70 million in FY 2004. These resources include funding for personnel compensation and benefits, administrative travel, training, rent, IT investments, administrative contractual services, supplies, equipment, and other operating expenses necessary for management of NSF's research and education activities.

- **Office of Inspector General** (OIG) increases to $8.77 million in FY 2004 and funds 60 FTEs. These resources include funding for personnel compensation and benefits, contract audits, training, 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 to $56.89 million in FY 2004. These costs include funding for personnel appointments under the Intergovernmental Personnel Act (IPA) and administrative contracts and requisitions that directly support programs. Support costs also include funding for Foundation-wide evaluation contracts and development costs associated with NSF customer-focused information technology projects, including FastLane.

Administration & Management by Appropriations Account
(Dollars in Millions)

	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	Change Amount	Change Percent
Salaries and Expenses	174.01	208.95	231.70	22.75	10.9%
Less Reimbursements [1]	4.08	6.00	6.00	0.00	0.0%
Subtotal	169.93	202.95	225.70	22.75	11.2%
Office of Inspector General	6.70	7.70	8.77	1.07	13.9%
Financial Statement Audit [2]	[0.66]	[0.70]	[0.80]	[-0.10]	[-0.14%]
Administrative Activities funded in:					
Research & Related Activities	38.23	35.35	41.52	6.17	17.5%
Education and Human Resources [3]	15.72	14.57	15.37	0.80	5.5%
Travel	[15.00]	[16.00]	[17.00]	[1.00]	[6.3%]
Total	$230.58	$260.57	$291.36	$30.79	11.8%

[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 A&M expenses for H-1B Nonimmigrant Petitioner Receipts.

HIGHLIGHTS OF RECENT ACCOMPLISHMENTS IN A&M

Although NSF's budget has nearly doubled in the last ten years, the agency's staffing level has remained relatively constant until the FY 2003 Request. Maintaining operations overhead at approximately five percent of the agency's total budget is an ongoing challenge as workload has grown more complex with involvement in more multi-disciplinary, partnership and international activities, as well as new large research facility projects. The agency has accommodated its increased funding and programmatic responsibilities by leveraging its agile, motivated workforce and continuing to re-engineer business processes to enhance productivity. Currently, NSF is the only federal research agency routinely receiving and processing virtually all of its proposals electronically.

In FY 2002, in line with the Administration's call for better management and improved program performance, NSF engaged considerable efforts in a wide range of activities, several of which are highlighted here:

- *Developed a Strategic Plan for Administration and Management*: In FY 2002, NSF finalized a comprehensive strategic plan for its investments and responsibilities in administration and management (A&M). The plan builds upon efforts begun in FY 2000 and FY 2001, to plan for new information technology (IT) investments and to assess the impact of new systems and processes on the NSF workforce. The A&M Strategic Plan *(http://www.nsf.gov/od/am)* elevates these earlier efforts by linking them directly to the five government-wide initiatives included in the President's Management Agenda (PMA). The Plan serves as a working roadmap, providing a set of goals that will drive the effective development and strategic management of the agency over the next three years. Central to the plan is the comprehensive multi-year business analysis discussed throughout this chapter, which will inform progress in each of the initiatives and will ultimately result in an organization that conducts business with even greater efficiency and productivity.

- *Initiated Business Analysis:* Realization of the strategic goals outlined in the Administration and Management Strategic Plan must begin with a knowledge of the agency – the current staff competencies and skill mix, core business processes and current IT systems and applications. NSF has engaged the services of Booz Allen Hamilton, a global leader in strategic planning and technology consulting, to assist the agency in developing a comprehensive documentation of the Foundation's current business process, human capital and IT environments. The outcomes of this analysis will guide long-term administration and management investments that promise important results for the agency's operations. The analysis will enable NSF to respond to challenges such as the management of an increasingly interdisciplinary research and education portfolio and management and oversight of a growing number of complex large facility projects. It will also help the agency respond to issues raised in the President's Management Agenda, by NSF's Office of Inspector General, and to government-wide issues identified by the General Accounting Office. Initial results are expected in FY 2003.

Cost Efficiencies Realized in FY 2002

Doing more with less and working smarter by instituting more efficient and cost-effective business processes have always been NSF hallmarks. In FY 2002, the agency re-engineered a number of business processes that yielded significant cost savings. It is conservatively estimated that cost efficiencies realized in FY 2002 totaled nearly $540,000.

- *Electronic information dissemination*: NSF launched its external business web site in 1994. As customer access to the Internet expanded over the years, NSF began offering its most popular documents online. Today, virtually all NSF publications are electronically available. In FY 2002, no program announcements were printed or mailed; there were 74,000 online downloads of the *NSF Bulletin*, a monthly document describing NSF funding opportunities; and over 35,000 monthly downloads of the *Grant Proposal Guide*. Compared with the prior year, in FY 2002, printing costs dropped 22 percent -- from $500,000 to $392,000 – for a cost savings of $108,000.

- *Bulk Mailing Costs*: With the decrease in printed publications, bulk mailing costs have also decreased significantly. In FY 2002, there was a 45 percent decrease in the number of pieces of bulk mailings – from nearly 206,000 in FY 2001 to about 114,000 in FY 2002. This resulted in a savings in bulk mailing costs of $35,000 -- from $102,000 in FY 2001 to about $67,000 in FY 2002.

- *POD/Electronic Review*: NSF created "Print on Demand" (POD) to encourage the growth of electronic proposal reviews. POD precludes the need for printing multiple copies of proposals because reviewers can access proposals electronically or, if they prefer, submit a POD request for paper copies to be sent to them. As a result of the availability of POD, in FY 2002, there was a significant increase in the number of programs that adopted the electronic review process. Of the 447 programs that participated in the POD/electronic review program in FY 2002, 48,973 proposals were actually printed compared to the 170,520 proposals that would have been printed if not for POD. It is estimated that, based on an average cost of $3.43 for printing and mailing a proposal, NSF saved at least $203,415.

- *Electronic Signatures/Jackets*: Prior to electronic signature implementation in FY 2002, paper signatures were obtained from organizations submitting proposals and supplements. The majority of these were submitted through express mail, and most were single signature page submissions. With about 35,000 proposals and 6,000 supplements submitted in FY 2002 and assuming express mail costs average about $8.00, savings for NSF's research and education community is conservatively estimated at $300,000. On the NSF side, a computer specialist was freed-up from the full-time task of opening paper signature submissions, entering them in the electronic systems and working with NSF divisions who placed these signatures in paper jackets. These processing steps were eliminated in FY 2002, for a conservative estimated savings of $40,000.

- *Videoconferencing*: Following September 11, there was considerably more interest in videoconferencing, and in FY 2002, videoconferencing became a mainstream meeting technology at NSF. NSF supported 110 videoconferences in FY 2002; program offices have reported that they have been able to reduce travel costs by scheduling videoconferences for a least some of their attendees. For example, one program office estimated that in FY 2002, videoconferencing saved about $140,000 in panel travel costs. The funding was then available for other program costs.

- *Online Self-booking Travel*: In FY 2002, NSF adapted an online self-booking tool, FedTrip, for staff travelers. Advantages in using FedTrip include flexibility for the traveler in making his/her own reservations and the ability to make changes up to the time of ticketing. In terms of cost savings, per ticket fees have dropped by more than half – from $34 to $15 – per ticket. Since November 2001, 520 tickets have been issued, saving NSF nearly $9,880 in fees. This number will continue to grow as users become more comfortable with self-booking.

FY 2004 GPRA PERFORMANCE GOALS FOR MANAGEMENT

PERFORMANCE AREA	NO.	ANNUAL PERFORMANCE GOALS FOR MANAGEMENT
Proposal and Award Management		
Use of Merit Review	IV-1	At least 85 percent of basic and applied research funds will be allocated to projects that undergo merit review.
Implementation of Merit Review Criteria – Reviewers	IV-2	At least 70 percent of reviews with written comments will address aspects of both review criteria.
Implementation of Merit Review Criteria – Program Officers	IV-3	For at least 90 percent of decisions to fund or decline proposals, Program Officers will comment on aspects of both review criteria.
Customer Service – Time to Prepare Proposals	IV-4	Ninety-five percent of program announcements will be publicly available at least three months prior to the proposal deadline or target date.
Customer Service – Time to Decision	IV-5	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.
Efficiency – Award Size	IV-6	NSF will increase the average annualized award size for research grants to $128,000.
Efficiency – Award Duration	IV-7	The average duration of awards for research grants will be 3.0 years.
Facilities – Construction and Upgrade	IV-8	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.
Facilities – Operations & Management	IV-9	For ninety percent of operational facilities, keep scheduled operating time lost to less than 10 percent.
Business Practices		
Cost Efficiency – Videoconferencing	IV-10	NSF will assess the cost efficiencies associated with administrative processes. Performance Indicator: - Calculation of the agency-wide cost savings realized by the use of videoconferencing.
Electronic Business	IV-11	NSF will continue to integrate its internal electronic grants process with the E- government initiative. Performance Indicators: - 90 percent of program announcements will be posted to Fed Grants. - 75 percent of declined proposals will be processed using E-decline signatures.

FY 2004 GPRA PERFORMANCE GOALS FOR MANAGEMENT (CONTINUED)

PERFORMANCE AREA	NO.	ANNUAL PERFORMANCE GOALS FOR MANAGEMENT (CONTINUED)
Security Program – Information Technology & Physical Security	IV-12	NSF will maintain and enhance the agency-wide security program to ensure adequate protection of NSF's infrastructure and critical assets. Performance Indicators: - 95 percent of NSF's major systems will achieve Level 3 compliance in accordance with the NIST Security Self-Assessment Framework. - Implementation of a "Smart ID" pilot to provide staff with a standard identification card for authentication and access control.
Human Capital		
NSF Staff – Diversity	IV-13	NSF will ensure that diversity considerations are embedded in activities related to agency staffing of scientists and engineers. Performance Indicator: - NSF will complete development of the NSF S&E diversity plan initiated in FY 2003 and begin implementation of its recommendations.
NSF Staff – Diversity	IV-14	NSF will show an increase over FY 2000 in the total number of appointments to NSF science and engineering staff and management from underrepresented groups.
Workforce Learning	IV-15	The NSF Academy will develop a broad array of competency-based learning opportunities that will enable all staff to perform critical functions supporting NSF's vision and goals. Performance Indicators: - Identification of staff requiring Facilities / Center Project Management training. - Initiation of development of a curriculum that leads to certification in Facilities / Center Project Management.
Workforce Planning	IV-16	NSF will develop competency-based occupation classification alternatives that support the agency's strategic business processes and capitalize on its technology enabled business systems. Performance Indicators: - Identification of workforce competencies needed to support the majority of NSF's strategic business processes. - Development of new positions or revision of position descriptions in order to address emerging business process requirements.