NATIONAL SCIENCE FOUNDATION

Coalition for National Science Funding

The Coalition for National Science Funding (CNSF) thanks the Congress and the Administration for acknowledging the importance of the National Science Foundation (NSF) and supports the levels of budgeting outlined in the NSF Authorization Act. This Act, passed by the 107th Congress and signed into law by the President, represents a major milestone for the NSF and for the scientific community, as it authorizes raising the budget of the NSF from its FY 2002 level of approximately $4.8 billion, to the level of $9.8 billion in FY 2007. For FY 2004 the CNSF advocates raising the NSF budget to the authorized level of $6.39 billion.

Today scientific development often requires knowledge and discoveries across many disciplines. The NSF recognizes this, and encourages cross-disciplinary interactions within directorates and between directorates and programs, as well as with other federal agencies. The NSF has established a "virtual directorate" for environmental research and education. Through this virtual directorate, NSF coordinates the environmental research and education activities supported by all the directorates and programs.

The Major Research Equipment and Facilities Construction (MREFC) program enables the construction of large multi-user facilities needed for disciplinary and cross-disciplinary research. These state-of-the-art facilities are made available to researchers from around the country and are necessary to insure advanced research capabilities. The approved, peer reviewed list of MREFC projects is on the back of this page. The NSF also funds various centers that support a broad spectrum of cross-disciplinary research projects.

Science, mathematics, and engineering discoveries are the life-blood of technological invention and the research supported through the NSF has time and again underpinned a new technology, product, or method. These technologies, products, and methods have led to multi-million dollar industries, helped create jobs, and have contributed to economic prosperity and to national security. NSF supported science helps us to better understand our planet and provides a scientific framework for better decision-making.

In this folder, we highlight opportunities for new science, mathematics, and engineering discoveries and innovation, as well as past accomplishments. In order to realize the scientific outcomes embedded in these opportunities, the NSF budget must reach the levels stated in the NSF Authorization Act of 2002.

Approved Major Research Equipment and Facilities Construction Projects

Atacama Large Millimeter Array (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 to 0.4 millimeters.

EarthScope is planned as a distributed, multipurpose geophysical instrument array that will make major advances in our knowledge and understanding of the structure and dynamics of the North American continent.

High-Performance Instrumented Airborne Platform for Environmental Research (HIAPER), is a multi-disciplinary 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.

IceCube is planned as a neutrino observatory that uses one kilometer of the Antarctic ice sheet as the detector medium and will open a new astronomical window, giving us, up to this time, an unseen view of the most active and energetic astrophysical objects.

National Ecological Observatory Network (NEON) will be a continental scale research instrument consisting of 10 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.

Ocean Observatories Initiative (OOI) will construct an integrated observatory network that will provide the oceanographic research and education communities with continuous access to the ocean. OOI will have three elements: a regional cabled network consisting of interconnected sites on the seafloor, several relocatable deep-sea buoys, and an expanded network of coastal observatories.

Rare Symmetry Violating Processes (RSVP) will test the Standard Model of particle physics, the extremely successful theoretical framework that describes fundamental particles and the way they interact.

Scientific Ocean Drilling will support the conversion, outfitting and acceptance trials of a deep-sea drilling vessel for use in a new international scientific ocean drilling program. The vessel is planned as a year-around operations platform that will be capable of operating in all ocean environments and that will accommodate a scientific and technical staff of approximately 50.

South Pole Station will be expanded to provide support infrastructure and utilities for 150 people, accommodating the increased interest in conducting research at the South Pole.

Coalition for National Science Funding

Alliance for Science & Technology Research in America (ASTRA)
American Association of Engineering Societies
American Association of State Colleges and Universities
American Astronomical Society
American Chemical Society
American Educational Research Association
American Geological Institute
American Geophysical Union
American Institute of Biological Sciences
American Institute of Chemical Engineers
American Institute of Physics
American Mathematical Society
American Meteorological Society
American Physical Society
American Physiological Society
American Psychological Association
American Psychological Society
American Society for Biochemistry & Molecular Biology
American Society for Cell Biology
American Society for Engineering Education
American Society for Microbiology
American Society of Agronomy/Crop Science Soc/Soil Science Soc
American Society of Civil Engineers
American Society of Limnology & Oceanography
American Society of Mechanical Engineers
American Society of Plant Biologists
American Sociological Association
Arctic Research Consortium of the U.S. (ARCUS)
Association for Women in Mathematics
Association of American Universities
Association of Environmental Engineering & Science Professors
Association of Research Libraries
Association of Universities for Research in Astronomy (AURA)
Battelle Memorial Institute
Biophysical Society
Coalition for Academic Scientific Computation
Columbia University
Computing Research Association
Consortium of Social Science Associations
Cornell University
Council for Chemical Research, Inc.
Council on Undergraduate Research
Ecological Society of America
Educational Testing Service
EDUCAUSE
Federation of American Societies for Experimental Biology
Federation of Behavioral, Psychological & Cognitive Sciences
Georgia Institute of Technology
Harvard University
Indiana University
Industrial Research Institute, Inc.
Institute of Electrical and Electronics Engineers-USA
Jorden Burt llp
Kent State University
Lewis-Burke Associates
Linguistic Society of America
Louisiana State University
Massachusetts Institute of Technology
Materials Research Society
Mathematical Association of America
Michigan State University
National Assoc. of State Universities & Land Grant Colleges
National Association of Geoscience Teachers
National Council for Science & the Environment
National Society of Professional Engineers
Natural Science Collections Alliance
Northwestern University
Ohio State University
Optical Society of America
Ornithological Council
Pennsylvania State University
Princeton University
Protein Society
Rutgers University-Washington Office
San Diego Supercomputer Center
Society for Industrial and Applied Mathematics
Society for Neuroscience
State University of New York at Stony Brook
University Consortium for Geographic Information Science
University Corporation for Atmospheric Research
University of California
University of California, Riverside
University of Cincinnati
University of Florida
University of Michigan, Washington Office
University of New Mexico
University of North Carolina
University of North Carolina, Chapel Hill
University of Wisconsin
Vanderbilt University
Virginia Polytechnic Institute and State University
Wayne State University

NATIONAL SCIENCE FOUNDATION

Biological Science

The Directorate for Biological Sciences supports basic research in the biological sciences, advancing understanding of the principles and mechanisms governing life. Research focuses on the structure and dynamics of organisms, ranging from the molecular level to the study of entire ecosystems.

OPPORTUNITIES

By studying island ecosystems such as this, biologists are better able to understand how space affects species abundance.

- Improved understanding of the interactions between organisms and their environment. For example, human activities are dramatically altering the nitrogen cycle. Agricultural and residential activities can be modified to reduce the impacts of excess nitrogen, such as poor water quality.

- Enhanced knowledge of the basic function and structure of cells, such as mutations in plant cell walls.

- Better understanding of the critical role proteins play in all life functions. Genes produce proteins which are the driving force behind all reactions in an organism's body.

Zebra Finch

- Long-term neural research on how Zebra Finches learn songs could lead to a better understanding of how humans learn to speak. Despite their obvious size difference, songbirds' brain "circuits" are similar to the parts of the human brain that handle motor control and learning.

- A nation-wide network of ecological observatories to broaden the nation's ability to assess and predict the status of the country's life support systems. Information gathered through this network will be used to measure all factors that affect the structure and function of ecosystems, which provide critical goods (i.e. fish) and services (purify water).

ACCOMPLISHMENTS

Plant Genomics & Economically Important Crops

A study that used microarray technology simultaneously explored the expression of thousands of genes in soybeans in order to better understand this economically vital plant's responses to drought and disease. A separate study on the petunia flower revealed changes in plant gene function that are inherited but that do not entail a change in DNA sequence.

Climate Change & Biodiversity

Path-breaking research on the potential impacts of climate change on species across the entire country of Mexico represents a major step in being able to predict likely impacts of climate change on ecosystems and on biodiversity.

Grass shrimp are not only a critical component of the food web, but are excellent indicators of aquatic contamination by such pollutants as heavy metals.

Key Cell Structures

A fundamental study of cellular biology led to a breakthrough in culturing important but poorly understood cell structures called Hirano bodies. Work on these cell structures could shed light on numerous diseases in which Hirano bodies may play some role—including Alzheimer's disease, Lou Gehrig' Disease, and cancer.

Microbes & Technology

Researchers have discovered many species of microbes that can exist in extremely hot or cold environments. This discovery has tremendous potential for industrial applications such as bioremediation. Past discoveries of such microbes have led to the development of new biotechnology and have had a direct economic impact. For example, the world market for an enzyme produced by a species of extreme microbe is currently valued at hundreds of millions of dollars.

Researchers are finding that acid deposition continues to negatively affect US forests.

Acid Rain Effects

Studies at long-term ecological research sites first revealed how acid rain negatively impacts U.S. forests and lakes. These sites continue to provide important data as the nation works to curb the pollutants that cause acid rain.

By taking soil samples such as these, researchers can determine the effects of overabundant populations of waterfowl on habitat.

Computer & Information Science & Engineering

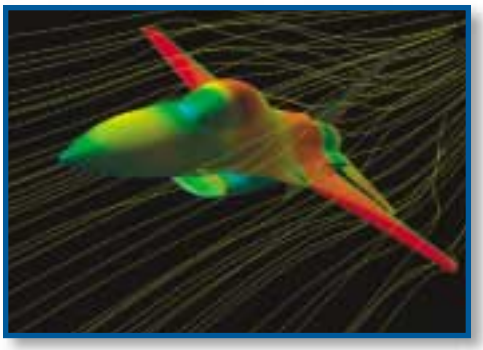
CISE

The Directorate of Computing and Information Science and Engineering (CISE) supports research on the theory and foundations of computing, system software and computer system design, human-computer interaction, as well as the development of cutting-edge computing and communications systems that address complex research problems.

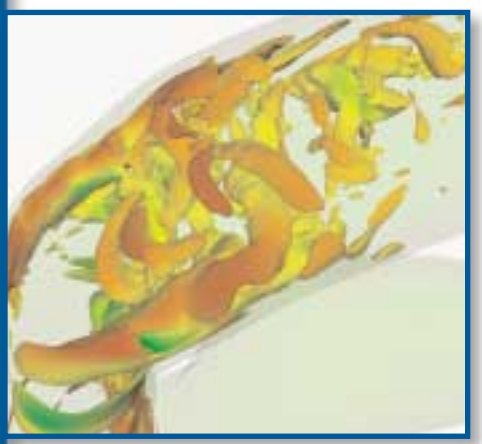
OPPORTUNITIES

- The Nation depends on fragile software—from defense to air-traffic control, banking to tax-collecting, and power-grids to aqueducts. Understanding how to build robust, bug-free software enhances our safety and productivity for these crucial (and not-so-crucial) applications.

- Dependence on the Internet as the basis for information needs (our "information infrastructure") continues to grow at a dramatic rate—a rate well beyond the intent of its original designers. Increased understanding of how to build and use large, complex, highly reliable and secure systems insures that the Internet will continue to grow as a stable, integral part of the lives of citizens.



Charbal Farhat of the University of Colorado modelled the effects of vibrations on an F-16 during the transition from subsonic to supersonic flight using the Pittsburgh Supercomputing Center's Terascale Computing System.

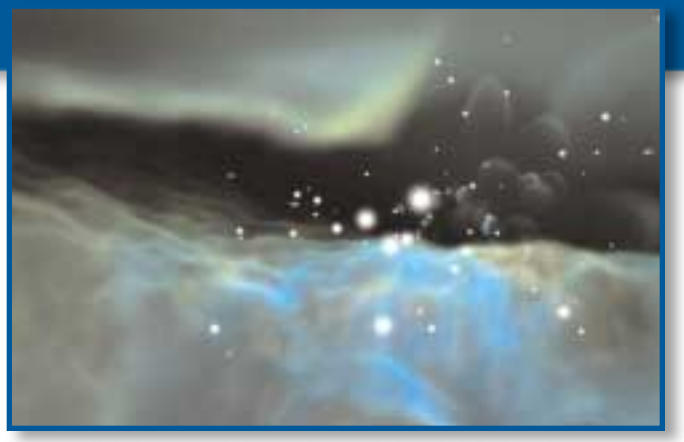


Researchers from Argonne National Laboratory, the University of Illinois and the University of Chicago used PSC's Terascale Computing System to simulate blood flow through the carotid artery, helping doctors understand the correlations between blood flow and strokes.

- High-end computing is critical to science and engineering research across disciplines. Improved understanding of computational simulation and modeling will enable applications that can "mine" very large databases for answers to questions in a variety of areas from health care to market research, enable computer assisted design in broad sectors like fashion and architecture, improve routing and fuel efficiency for aircraft more effectively, or help simulate crises to enable better training and preparedness.

- The increasing use of information technology has also introduced important and complex policy issues, including issues of equity and access, workforce issues, and protection of intellectual property and "fair use" rights for newly-enabled digital content. Socioeconomic and IT policy research will help address these issues as information technology moves forward.

ACCOMPLISHMENTS



A spaceship's eye view of the core of the Orion nebula. Image from the Hubble Space Telescope and a Rice University 3-D model, produced at the San Diego Supercomputer Center for use in the Hayden Planetarium show, "Passport to the Universe."

Transportation Applications

Computing researchers are developing dependable applications over ad-hoc networks, technology that when transferred to the automotive industry can enable collision warning systems, smart lane merging, rear impact avoidance, safety analysis across an entire fleet of vehicles, highway traffic optimization, and even "smart intersections" that allow cars to negotiate who goes first without stopping.

Cybersecurity

Researchers have developed a powerful new technique to combat a form of cyber crime known as Denial-of-Service (DoS) attacks. In a DoS attack, hackers cause a machine to send a large number of packets to the victim of the attack, thereby denying legitimate users access to this victim. The promising new technique determines the source of a DoS attack by tracing a stream of packets back to its source.

Understanding Our Universe

Researchers are using supercomputers to model one of the most dramatic events in astronomy—the behavior of black holes when their host galaxies collide. From revealing strong and unexpected effects on surrounding stars to the potential to produce rogue black holes wandering the universe, these simulations—among the largest of their kind ever run—are shedding new light on the life cycle of gravitationally bound black holes in the nucleus of a pair of merging galaxies.

NATIONAL SCIENCE FOUNDATION

Education & Human Resources

EHR

The Education and Human Resources Directorate (EHR) works to enhance the strength of our nation by creating a scientifically literate citizenry and building an inclusive, diverse scientific workforce. Reaching every educational level in every state, EHR provides universal access to scientific and technical knowledge and education across all scientific disciplines. Its impact is enhanced through linkages with federal, state and local agencies, museums, schools, universities and even everyday citizens. A champion for assessment and accountability, EHR directly measures the impact of its nationwide dissemination of successful learning models and leads the way in the integration of scientific research and science education. EHR provides the fuel for our nation's scientific enterprise.

OPPORTUNITIES

- An inclusive, diverse scientific workforce is more productive and more creative, taking advantage of talents from all people.
- New knowledge of how people learn and retain knowledge should drive educational and systemic reform, helping make K-12 science curricula more efficient and more effective.
- As universities and colleges implement a new paradigm for learning—experiential, investigative—to large classes, participation in science learning will increase.
- Expanded research and teaching fellowships supporting U.S. students will guarantee the steady production of the next generation of scientists by drawing students to pursue graduate education in the sciences from all walks of life.
- A well-informed, well-educated citizenry understands the impact of science on their every-day life and enables good decision-making. Sharing scientific knowledge in effective exhibits at museums and science centers in combination with diverse media programming for all ages is the foundation of this educational process.

Undergraduate students perform research at the NSF-supported Pennsylvania Regional Center for Nanofabrication Manufacturing Education, Penn State University.

ACCOMPLISHMENTS

Students in the Integrated Natural Resources Program at Mt. Hood Community College record bird songs as part of their NSF-supported wildlife research.

Positive Change

Just a few years after the release of studies on teacher preparation in two-year colleges, the number of such colleges including teacher preparation in their mission increased from 0 to 330.

Establishing centers for learning and teaching has allowed the dissemination of field-tested science learning across the country. These centers have demonstrably increased the number, professionalism and diversity of K-12 math and science teachers.

Positive Partnerships

Innovation partnerships that link scientific knowledge (researchers, faculty, students) with talent in local communities has enhanced the nation's economic strength and workforce by building connections between fundamental scientific research and the broader industrial community.

Eastern Iowa Community College District students in Bettendorf, Iowa participate in field training in hazardous materials under an NSF grant.

By guiding a partnership between government, non-profit organizations, industry and academic institutions, the world's largest digital library for children was envisioned, designed and created.

NATIONAL SCIENCE FOUNDATION

Engineering

ENG

The Directorate for Engineering (ENG) at the National Science Foundation is responsible for six divisions and contributes to several cross-disciplinary initiatives. The divisions include Bioengineering & Environmental Systems, Chemical & Transport Systems, Civil & Mechanical Systems, Design, Manufacture & Industrial Innovation, Electrical & Communications Systems, and Engineering Education & Centers.

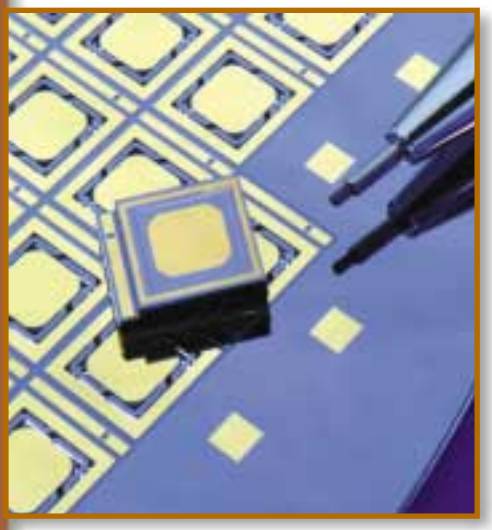
OPPORTUNITIES

- Nanotechnology, the development of materials and systems at atomic, molecular or macromolecular levels, will impact virtually every sector of the economy, including medicine, manufacturing, energy, telecommunications, computers, and defense operations.

- Microelectromechanical Systems (MEMS), the world's smallest motors, switches, and circuits, currently used in fighter aircraft, airbag deployment and desktop printers, will improve the operation, reliability and affordability of future smart devices.

- Neuromorphic Engineering, including neuroscience, psychophysics, and biomechanics, will advance the state of mechanical sensory systems by replicating biological systems. Future machines will be able to interact, learn and adapt to their environment like living creatures.

A nanopore membrane protects insulin-secreting cells from anti-bodies.



This tiny accelerometer, with its very low noise floor, can collect multi-component data.

- Metabolic Engineering can reduce global warming by genetically altering certain bacterial organisms, which can capture and convert carbon dioxide into commercially useful compounds, such as cellulose, while simultaneously cleaning the air.

- Tissue Engineering and Gene Therapy may stimulate bone growth in osteoporosis and osteoarthritis patients more efficiently than existing therapies. Polymers, seeded with skin, cartilage, liver or other cells, can eventually grow into a functioning organ, providing options for patients awaiting scarce donor organs.

- Earthquake Engineering links earth science, engineering, and economics to improve the seismic design and performance of structures, utilities and other infrastructure and allow decision-makers to weigh the consequences of mitigation choices.

- Deception Detection in Communications requires sophisticated hardware and software to detect deceptive communications in cellular, text messaging and video communications to flag potentially deceptive and cryptic communications thereby enhancing homeland security.

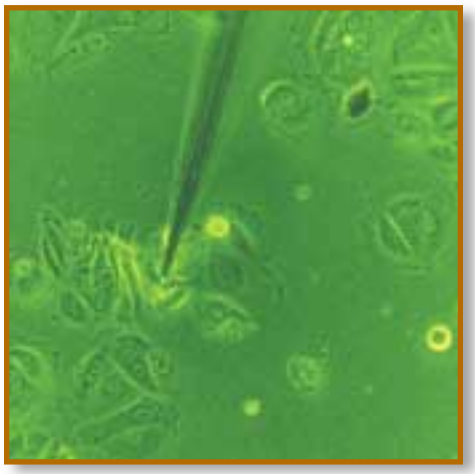
ACCOMPLISHMENTS

New Medicinal Treatments

Biomedically-Engineered Pharmaceuticals include dime-size chemotherapy wafers to treat brain, spinal and ovarian cancers and a "pharmacy-on-a-chip" implant prototype that monitors a patient's blood chemistry and will deliver accurate and timely doses of medicine.

Help for the Disabled

Healthcare Electro-Optical Locater (HEAL) uses existing yet modified fluorescent light fixtures to send digital and analog data to a hospital patient's Personal Data Assistant (PDA) to navigate the patient through the facility. Similar systems can be used to assist disabled persons, in security systems, minefield clearing, and other military operations.



This nanoneedle can probe individual cells to detect the presence of a carcinogen.

A New Diagnostic Light Source

Extreme Ultra Violet (EUV) light is a new short-wavelength light source that can measure and manipulate objects sized in nanometers. EUV light is 20-30 times smaller in diameter and several hundred times more intense than the common laser beam and can be used to observe molecular behaviors, to test manufacturing systems, and create high-resolution biological holograms.

Industrial Innovation

Droplet-Based Manufacturing is a new high-speed, computer-directed fabrication process of precision components, with promising applications in aircraft and electronic component manufacturing, that can save time and money by eliminating the need for molds and finishing processes.

Nano Applications

Nano-Engineered, Low-Friction Surfaces increase the energy efficiency of devices and machines, enabling them to operate with smaller, more portable motors. Low-friction surfaces are needed for the development of energy-efficient microfluidic devices such as labs-on-a-chip.

NATIONAL SCIENCE FOUNDATION

Geosciences

GEO

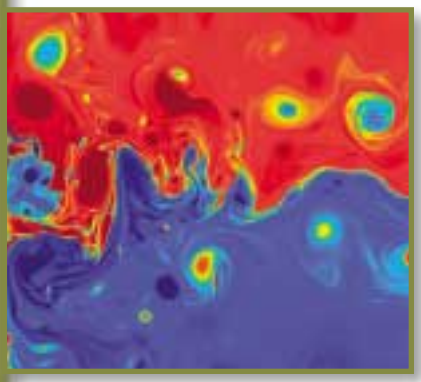
The Directorate for Geosciences supports fundamental research in the atmospheric, Earth, and ocean sciences, as well as cross-directorate programs in education and biogeosciences. Research in the geosciences has triggered tremendous advances in understanding our planet's natural processes, providing the nation with a sound scientific framework for better decision-making about the Earth. Geosciences is also a natural locus for interdisciplinary environmental research that cuts across and unites scientific disciplines.

OPPORTUNITIES

- Atmospheric sciences research will continue to focus on understanding weather systems and climate, air quality, space weather, and natural hazards.
- Research will explore key scientific questions that include understanding storm systems like hurricanes from genesis to decay, the role of the land-ocean interface in generating weather, and the conversion of meteorological data into information for decision-makers.
- State-of-the-art instrumentation aboard a new research aircraft will advance understanding of atmospheric sciences broadly.

Photo by Carlye Calvin

A radar used during one of the biggest weather field projects in North American history: International H2O Project.



Jeffrey B. Weiss, Univ. of Colorado, Boulder

Image from a simulation of an idealized wind-driven ocean basin, calculated by computers at the San Diego Supercomputer Center to allow a better understanding of the Earth's climate system.

- Better understanding of space weather will lessen disruption of space and ground-based technological systems.
- Advances in understanding fundamental atmospheric chemistry will continue to improve efforts at mitigating air pollution
- Earth science research will be geared toward understanding the structure, composition, and evolution of the Earth.
- A multidisciplinary study of the North American continent is expected to revolutionize scientific thinking about continental structure and dynamics. New technology and data management capabilities will allow scientists to probe North America through large seismic arrays, high-precision global positioning system receivers, directional drilling through an active fault and new, space-based, radar technology.
- New research will investigate microbial processes and how microbial activity influenced the co-evolution of the geosphere and biosphere.

- Future research will explore whether 20th century warming of the Arctic is unprecedented compared to the last 1,000 to 10,000 years.
- Ocean sciences research will advance our understanding of the oceans from shallow coastal waters to the deep ocean.
- Long-term, interdisciplinary observation systems will enable in-place measurements on timescales ranging from seconds to decades.
- Data and observations from new arrays of instruments will give oceanographers perspectives on the oceans previously unimaginable.

NSF/USAP photo by Josh Landis/RPSC (2000)

A graduate student breaks up a sample of igneous rock from the McMurdo Dry Valleys, Antarctica.

ACCOMPLISHMENTS

Climate Change and Weather

New observing systems and advanced computer models have provided a wealth of research information and greatly enhanced our knowledge of phenomena such as El Niño and its impact on society.

Paleoclimate studies have improved our understanding of past climate change as a baseline for comparison with current climate variability, especially rapid climate change.

Managing Earth Resources and Natural Hazards

Research results are being applied to more sustainable use of energy, mineral, soil, and water resources; mitigation of natural hazards; improved land-use planning and geotechnical engineering.

Hans Paerl; courtesy Univ. of North Carolina's *Endeavors* magazine

New Discoveries in the Ocean

Drilling and collecting samples from the ocean floor around the globe have given scientists a window into the geophysical history and structure of our planet. Advanced drilling technology and a new international partnership will allow bold new experiments on the ocean floor.

Discovery of hydrothermal vents, sometimes known as black or white "smokers", on the ocean floor triggered an explosion of research on life in extreme environments and the identification of over 300 new species.

A graduate student in marine science takes mid-river samples in the Neuse River in North Carolina to detect pollutant levels.

NATIONAL SCIENCE FOUNDATION

Polar Programs

The Office of Polar Programs supports research aimed at scientific questions that can only be answered effectively in the Arctic and Antarctic.

OPPORTUNITIES

- Arctic research seeks a coordinated understanding of ocean, land, atmosphere, biological, and human systems in the Arctic, including the Bering Sea and the Aleutians.
- Antarctic research is aimed at understanding the region and its ecosystems and its effects on (and responses to) global processes such as climate. Researchers also use the region as a unique platform to study the upper atmosphere and space.
- Research will identify the patterns and mechanisms driving Arctic sea ice and permafrost melting, their impact on global climate and on indigenous peoples.
- New research will explain why major ice streams, like the Pine Island Glacier in Antarctica, are thinning and accelerating the flow of ice into the ocean.

Photo credit: Peter West/National Science Foundation

A NSF-funded researcher from the University of Chicago uploads new instructions to an automated weather station on iceberg B-15A.

ACCOMPLISHMENTS

New Discoveries in the Ice and Below

Discovery of hydrothermal vents (black smokers) on the Gakkel Ridge in the Arctic Ocean made possible through unprecedented access to the ocean floor.

Lake Vostok ice cores revealed 420,000 years of climate information.

Life in Extreme Environments

Identification of anti-freeze proteins (AFPs) in marine fish, insects, plants, fungi, and bacteria. Understanding how AFPs work holds great promise for preservation of biomedical materials, foods and agriculture.

Gerald Kooyman, NSF/ Scripps Institution of Oceanography

A group of emperor penguins photographed at Cape Crozier.

Unique Window Into Space

Discovery that 95% of the mass and energy in the universe must reside in as-yet-undiscovered forms and objects.

The first measurement of the polarization of microwaves emitted in the early history of the universe gives new insight into its early evolution.

Polar

NATIONAL SCIENCE FOUNDATION

Mathematical & Physical Sciences

The Directorate for Mathematical and Physical Sciences and its divisions—Astronomical Sciences, Chemistry, Materials Research, Mathematical Sciences, Physics, and Multidisciplinary Activities—strive to deepen our understanding of the physical universe and use this understanding in service to society. From sub-atomic particles to the most distant galaxies in the Universe; from chemical interactions to the bulk properties of materials; from the most fundamental equation to the most complicated computational methods; the physical and mathematical aspects of the world we live in play a vital role in our day-to-day lives.

OPPORTUNITIES

- The development and construction of new astronomical telescopes and instruments, enabling astronomers to observe further, at finer detail and in new wavelength regimes, which will increase our understanding of the Universe.
- The development of an electronically connected digital archive of the changing night sky, a virtual observatory that will enable more science to be accomplished by more researchers more easily than ever before.
- New advances in chemical methods will allow the creation of cleaner industrial technology and address problems of carbon sequestration.

Gemini Observatory—GMOS Team

The galaxy NGC 628 .

- The development of new materials, pharmaceuticals and industrial processes from the quantum level upwards will arise from innovations in theoretical and computational chemistry.
- New laser technologies, quantum optics and microscopy will open new avenues for the study of atomic and molecular behavior at scales ranging from the macroscopic to Bose-Einstein condensates.
- The development of new techniques in chemical synthesis will allow an understanding of bio-molecular systems and machines for the first time.
- New materials science and tools will impact innovations in semiconductors, biotechnology, pharmaceutical, aerospace, energy, optoelectronics and defense materials and systems.
- The next generations of electronic materials will continue the rapid increase in computer speed and memory density characterized by “Moore’s Law”.

American Chemical Society

Analysis of new materials.

MPS

American Chemical Society

Learning science by doing...

- New mathematical theories and computational techniques will address critical issues in optical fiber communications technology, such as optical switch technology.
- Mathematical theory and modeling will allow better understanding of the spread of epidemics, of DNA, of brain function and of the three-dimensional interactions of proteins—an enormous, complex problem of biology.
- Exploitation of advanced technological tools, such as synchrotron light sources, supercomputers, accelerators, neutron sources, and newly developed gravity-wave observatories will promote fundamental understanding across scientific disciplines, among them materials, semiconductors, chemical dynamics, cosmology, and fundamental forces.

ACCOMPLISHMENTS

New Physical Knowledge and Enhanced Understanding

The discovery of planets around other stars, more complete understanding of the first moments of the Universe and the processes of star and planet formation and development.

Advancements in number theory have led to advances in cryptography and improved internet security.

New Tools and Novel Technologies

A new synthetic tool called Atom Transfer Radical Polymerization (ATRP), is considered to be the most robust method for creating a large variety of polymeric materials.

The development of a nano-scale self-assembly technique for making composite materials that could be used for making artificial bone and for repairing nerve fibers.

New information technologies developed through single atom manipulation techniques and new types of lasers with applications in medicine, communications and materials research.

Recent advances in diverse areas of physics have led to improved atomic clock precision and better global position system (GPS) resolution benefiting navigation, communications and weapons guidance.

NRAO/AUI and J. Hibbard

The Antennae galaxies.

NATIONAL SCIENCE FOUNDATION

Social, Behavioral & Economic Sciences

The Social, Behavioral, and Economic Sciences Directorate (SBE) funds researchers to build fundamental knowledge of human behavior, interaction, social and economic systems, organizations, and institutions. The Behavioral & Cognitive Sciences division supports basic research in cognition, perception, language, development, emotion/affect, social psychology, anthropology, archaeology, geography and spatial science. The Social and Economic Science division supports research focusing on economic, legal, political and social systems, organizations, and institutions. In addition, SBE supports research on the intellectual and social contexts that govern the development and use of science and technology.

OPPORTUNITIES

- Advance an understanding of behavior and performance at the individual, social, and population levels through capitalizing on the convergence of research in biology, engineering, information technology, and cognition.
- Develop the infrastructure needed to support transformative interdisciplinary research, such as large scale social and economic change, as well as the broad range of infrastructure needed to support this research.
- Examine decision-making and risk-related behavior under conditions of uncertainty in various circumstances.

Courtesy of Michael F. Goodchild

Layers of spatial information represented in a geographic information system allow integration of human and physical factors, improving our understanding of social systems.

- Research to enable understanding of large-scale transformations such as globalization and democratization.

- Utilize new instruments of science and data collection to investigate the full spectrum of social and behavioral research questions.
- Research learning to provide a better understanding of how children learn, and the application of this knowledge, which could be used to improve the preparation of the 21st Century workforce.
- Improve our knowledge of cognition, as well as developmental and human sciences by bringing together such areas as cognitive development, cognitive science, developmental psychology, linguistics, neuroscience, anthropology, sociology, family studies, human ecology, cross-cultural research, and environmental psychology.

SBE

Courtesy of Michael F. Goodchild

Mapping is a powerful tool for detecting patterns, anomalies, and trends in social systems.

- Develop an understanding of adaptive properties of collective human behavior, which contribute to the avoidance of organizational failure, and can aid civil defense planning and performance as well as the survivability of various elements of the social infrastructure.

ACCOMPLISHMENTS

Reactions and coping

Post-September 11 research in social psychology, studying issues such as: predicting affective reactions to collective loss; understanding how individuals respond to a salient and pervasive health threat such as anthrax; uncovering resiliency and coping in the wake of the attacks and ongoing threats.

Child achievement and schooling

Research on learning that has revealed primary social mechanisms that can contribute to differences in children's academic achievement, as well as an examination of the role schools play in society's system of stratification and how historic patterns of advantage and disadvantage are perpetuated across generations.

Regulation

Cost/benefit analysis that has been an important tool in regulatory responses, such research in human judgment and decision-making, and established laboratory experiments as a tool in empirical economic analysis.

Courtesy of Michael F. Goodchild

Cities are complex social systems, driven by interactions at scales from the neighborhood to the metropolis.

Crisis behavior

An unveiling of fundamental aspects of human and organizational behavior during acute crises (natural disasters, terrorist attacks, extreme hazards).

Neuroscience

The methods of neuroscience are being used to map psychological mechanisms onto the physical dimensions of the brain.