IV. INVESTMENT PRIORITIES

NSF establishes well-defined priorities to allocate investment funds and internal resources effectively. The priority-setting process draws upon contributions from a broad cross section of the science and engineering community, including NSF Advisory Committees. The resulting priorities, along with NSF's investments supporting basic research across all fields, are central to maintaining the vitality of the U.S. research and education enterprise and demonstrate our commitment to eminence as a steward of the nation's resources.

Our ongoing portfolio of investments and continuing priorities are outlined in our annual budget submission. In addition, we list here a number of investment priorities, associated with our strategic goals, which NSF has identified for increased emphasis or additional funding during 2006-2011.

A. Discovery

- ***Promote transformational, multidisciplinary research.*** NSF will emphasize investigations that cross disciplinary boundaries and require a systems approach to address complex problems (e.g., the neural basis of behavior, natural hazards and grid technologies) at the frontiers of discovery.
- ***Investigate the human and social dimensions of new knowledge and technology.*** NSF will integrate research on ethics, safety considerations and virtual communities from the outset in new research and in the applications of emerging technologies.
- ***Further U.S. economic competitiveness.*** NSF has a major role in the ACI. We will invest in basic research and in the tools of science to focus on fundamental discoveries that could have the potential to produce economically important technologies, processes, and techniques.
- ***Foster research that improves our ability to live sustainably on Earth.*** To strengthen our understanding of the links between human behavior and natural processes, research may range from investigations of deep oceans to urban centers and from basic energy science to climate science.
- ***Advance fundamental research in computational science and engineering, and in fundamental, applied and interdisciplinary mathematics and statistics.*** Beyond accelerating disciplinary progress, investments in these fields are needed to drive discovery in every science and engineering discipline and to power

East Asia and Pacific Summer Institutes

The frontier challenges of science and engineering are increasingly global. Future generations of the U.S. science and engineering workforce will need to collaborate across national boundaries and cultural backgrounds, as well as across disciplines. NSF's East Asia and Pacific Summer Institutes (EAPSI) program provides graduate students with a hands-on international research experience and an advantage in developing the problem-solving, teamwork and communication skills necessary to succeed in the global research arena. The EAPSI program prepares future U.S. scientists and engineers to competently engage in the rapidly expanding science and technology frontier of the East Asia and Pacific region.

Each year, the EAPSI program sends hundreds of U.S. science and engineering graduate students to Australia, China, Japan, Korea, New Zealand and Taiwan, where they work side by side with professors and peers from leading universities and laboratories on science and engineering challenges in those locations. The cross-cultural experience exposes EAPSI students to the diversity of ideas that drives innovation, and it prepares them for leadership roles in the global research enterprise. In recent years, participants have conducted research in areas ranging from humanoid robotics, nanofabrication and earthquake engineering to evolutionary biology, sensory integration, bionanomaterials and science and technology education.

For example, a behavioral biology student from Texas A&M University established a live Web "panda cam," at China's Wolong Nature Reserve, and completed a preliminary study on the ability of giant pandas to recognize their kin. Through the EAPSI, she opened a door for researchers and the broader public around the globe to observe the behavior of pandas in their natural habitat.

A recent EAPSI project produced a novel Web-based surveillance system for studying panda behavior.

the use of next-generation cyberinfrastructure and networking.

B. Learning

- ***Build strong foundations and foster innovation to improve K-12 teaching, learning and evaluation in science and mathematics.*** NSF will support education research, develop model programs and effective assessment methodologies, and disseminate best practices towards helping students achieve and demonstrate proficiency in math and science. NSF will broaden partnerships with others, especially among federal and state agencies.
- ***Advance the fundamental knowledge base on learning, spanning a broad spectrum from animals and humans to machines.*** Fundamental knowledge—from neuroscience to socio-cultural dimensions—will permit researchers to address a wide range of societal challenges, including understanding how people learn, establishing best educational practices, improving workforce preparation, and facilitating the adoption and integration of new technologies in society.
- ***Develop methods to effectively bridge critical junctures in STEM education pathways.*** Methods will focus on junctures between K-12 and undergraduate scientific and technical education and will support continuous pathways to a variety of career options.
- ***Prepare a diverse, globally engaged STEM workforce.*** NSF will focus on broadening participation in STEM disciplines. We will work with academic and industry partners to ensure that STEM education and workforce preparation are broadly available, for the technical workforce as well as for future scientists and engineers, and provide the skills and knowledge needed to flourish in a global knowledge economy.
- ***Integrate research with education, and build***

International Polar Year (IPY)

NSF continually seeks out research opportunities with the potential to transform entire areas of science and engineering, and to propel understanding far beyond current frontiers. One highly visible example is the International Polar Year (IPY). From March of 2007 to March of 2009, NSF will lead an interagency effort to comprehend the Earth's extreme latitudes at scales from the global to the molecular, to train new researchers for careers in science and engineering, and to communicate to the public about the importance of the polar regions.

In the process, researchers will begin to answer some of the most profound questions in geoscience and biology. Among them:

- What is the history of the planet's vast ice sheets? How did they form, how did they respond to past climate patterns, how are they changing, and what is the prospect for rapid alteration?
- How does life adapt itself to extreme cold and prolonged darkness? How are those adaptations manifested in cellular structure and genome?
- What is happening in the Arctic? How are the region's physical, chemical, biological and human components interrelated? And how can we create a comprehensive, long-term observational network to supplant the scattered and uncoordinated record of measurements that now exists?

NSF's new South Pole Station will support IPY science initiatives from astrophysics to zoology.

The NSF-funded research station at Toolik Lake, Alaska will play a key role in the International Polar Year.

The International Geophysical Year 1957-1958 ushered in a new era of global science and international cooperation, witnessed the creation of more than 50 research stations, and paved the way for the Antarctic Treaty. Half a century later, the IPY will enable an even greater expansion in the depth and breadth of knowledge through multi- and interdisciplinary projects, the creation of long-awaited infrastructure, the collection of unprecedented datasets, and the creation of new, more expansive international collaborations.

capacity. NSF will develop research and education capacity across the full spectrum of the nation's educational institutions, and utilize advanced cyberinfrastructure to transform the way we learn, teach and prepare an IT-literate workforce. NSF will renew a focus on 2- and 4-year colleges and minority-serving institutions, and will promote faculty enrichment programs, curricular improvements and access to research instrumentation. NSF will enhance opportunities for partnerships among community and technical colleges, 4-year colleges, and research-intensive universities.

- ***Engage and inform the public in science and engineering through informal education.*** NSF will improve STEM literacy by developing new strategies that explicitly encompass both formal and informal education, with a focus on strategies that have an impact on the nation's critical need for a citizenry literate in science and technology, a skilled workforce, and a vibrant research community. To have the greatest impact, NSF will encourage awardees, especially Centers, to broaden collaborations in order to leverage resources for outreach efforts.

C. Research Infrastructure

- ***Fill the gaps in our ability to provide enabling research infrastructure.*** NSF will raise current limits on instrumentation funding opportunities, where appropriate, to allow for funding of needed mid-sized instrumentation.

Informal Education

By the time our children reach the age of 18, they have spent approximately 12% of their lives in school, approximately 33% sleeping, and perhaps10-12% eating, bathing, and performing other daily routines. This leaves over 40% of time that is likely spent in informal or unstructured activity. It is safe to say that as much, if not more, actual learning takes place in this 40% as occurs in their formal education. This is why NSF invests heavily in informal math, science and engineering education, in addition to investments in curriculum development, teacher enrichment and formal education. If these subjects can be presented in ways that children (and adults) enjoy and choose for entertainment, the impact can be enormous.

Film is an entertainment medium of choice for most Americans, and athletes are our heroes. NSF partnered with the Partners Health Care, National Geographic and others to take viewers on a spellbinding ride through the Tour de France, and simultaneously through the human brain. The movie combines spectacular big-screen footage of the race with state-of-the-art computer animations of the human brain and describes how each new experience stimulates brain growth and adaptation, and how the brain responds to experience and challenge in ways we are only just beginning to understand.

Museums also play a major role in informal education, stimulating interest in science and technology through their exhibitions and programs. An example is the NSF-funded *Star Wars: Where Science Meets Imagination* developed by Boston's Museum of Science. Based on a collaboration with Lucasfilm Ltd., the exhibition takes advantage of popular culture to draw new audiences into learning about current scientific research and emerging technologies that relate to robotics and modes of transportation portrayed in science fiction. It stimulates interest and promotes technology literacy through interactive and immersive experiences, such as engineering "labs" where visitors can build and test their designs. Innovative hand-held multimedia devices allow visitors to bookmark content and e-mail it to themselves. This major traveling exhibition is on national tour, accompanied by educational programming for the public, students and teachers.

"Star Wars: Where Science Meets Imagination," a traveling NSF-supported museum exhibition, prompts curiosity wherever it goes.

NSF funds educational film projects such as "Wired to Win," which combines neuroscience and the Tour de France.

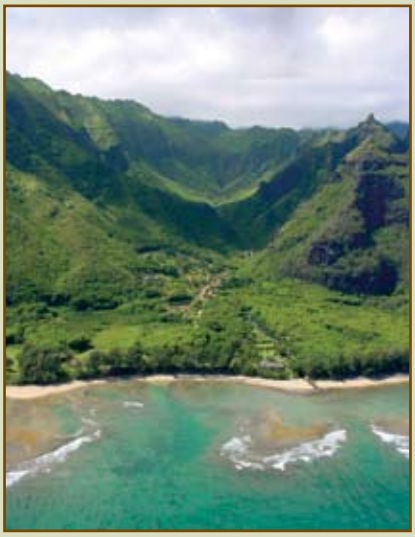
- ***Identify and support the next generation of large research facilities.*** NSF will work with the science and engineering community to identify the next generation of major equipment and facilities to enable transformational research. We will also fund the development of new capabilities, technologies, and instrumentation that could lead to the establishment of next-generation facilities.
- ***Develop a comprehensive, integrated cyberinfrastructure to drive discovery in all fields of science and engineering.*** NSF will initiate the first steps toward the development of a petascale computing facility; investigate the development of a next-generation Internet; and advance a wide variety of generic and domain specific cyberinfrastructure projects to further innovation in the field and to support global-scale research and education.
- ***Strengthen the nation's collaborative advantage by developing unique networks and innovative partnerships.*** NSF will connect science and engineering researchers and educators in academic organizations, industry and informal science institutions, both nationally and internationally, to leverage intellectual capabilities.

D. Stewardship

- ***Strengthen our traditional partnerships and develop new collaborations with other agencies, organizations and corporations, identifying common goals that can unite and focus partnerships.***
- ***Expand efforts to broaden participation from underrepresented groups and diverse institutions in all NSF activities.*** NSF will continue to enforce its merit review policy and increase the diversity of reviewers; increase its competi-

Experimental Program to Stimulate Competitive Research (EPSCoR)

Our future prosperity depends on a continuous supply of knowledge and innovation—discoveries that will solve the challenges of today, and will tomorrow bring a better quality of life, new technologies and even completely new industries. But discovery doesn't just happen. It requires effective, interactive networks of scientists, engineers and educators to elaborate ideas; equipment and infrastructure to test those ideas; and diverse sources of support to help turn ideas into reality. A robust national network will have distributed capacity, employ the talents of a broad segment of the population, and sustain itself through excellence in education and infrastructure.



In Hawaii, NSF-supported EPSCoR programs are enabling innovative research and education in ecology.

Creating and sustaining those conditions is a major goal of NSF's Experimental Program to Stimulate Competitive Research (EPSCoR). EPSCoR is a joint program of NSF and several U.S. states and territories that promotes the development of the states' science and technology resources through partnerships involving universities, industry, state and local government, and the Federal research and development enterprise. EPSCoR operates on the principle that aiding researchers and institutions in developing research capacity and infrastructure will maximize the potential for the state's research efforts to contribute solutions for society's challenges and advance economic growth.

A new West Virginia EPSCoR award will create a world-class research capacity in molecular recognition for biometric applications involving West Virginia University, Marshall University and West Virginia State University. The research could lead to robust, low-cost instruments with multiple applications in homeland security, health, forensic science and other fields. The program's partnership with West Virginia State University, a historically black university, will also target the integration of research with education and the recruitment of underrepresented students and faculty into the state's science and technology enterprise.

West Virginia students have sophisticated new resources and programs thanks to EPSCoR projects.

Another recent EPSCoR award will exploit the unique environment of the Hawaiian Islands, a natural laboratory for investigating ecological and genetic factors that govern ecosystem evolution adaptation to environmental change. The award will fund cyberinfrastructure and advanced environmental sensor technology, evolutionary genetics and ecosystems research, educational outreach, and recruitment and retention activities focused on Hawaii's diverse population. It promotes exciting science; responsible stewardship of Hawaii's ecosystems; and the development of technologically literate, critically thinking citizens for Hawaii's 21st Century workforce.

tive awards investments in the participation of groups, types of institutions, and geographic regions underrepresented in STEM; and continue to increase the diversity of NSF's STEM workforce.

- ***Improve our processes to recruit and select highly qualified reviewers and panelists.*** NSF will recruit potential reviewers and automatically add new investigators to an integrated, Foundation-wide database of reviewers, establishing an increasingly diverse pool of highly qualified reviewers for future selection. Reviewers and panelists will reflect the diversity in our community.
- ***Recruit, hire and empower highly qualified professional staff members who reflect the diversity of our community.*** Program Officers, Division Directors and other science and engineering professional staff are the principal means by which NSF projects values and receives ideas from the science, engineering and education research communities. We must continue to attract and, for permanent staff, retain scientists, engineers and educators with the necessary expertise, experience and impeccable reputations to act as stewards of national research and education programs.
- ***Develop mechanisms to improve training and mentoring for Program Officers.*** NSF will increase efforts to identify and disseminate best program management practices. Training and development are particularly important for "rotators" who bring valuable expertise and new ideas to the organization but stay for a limited amount of time, normally less than two years. We expect program officers to exercise their professional judgment.
- ***Implement the NSF Human Capital Management Plan.*** This plan was developed to strengthen management of the NSF workforce. It includes measures to increase the timeliness of recruitment activities, to improve retention

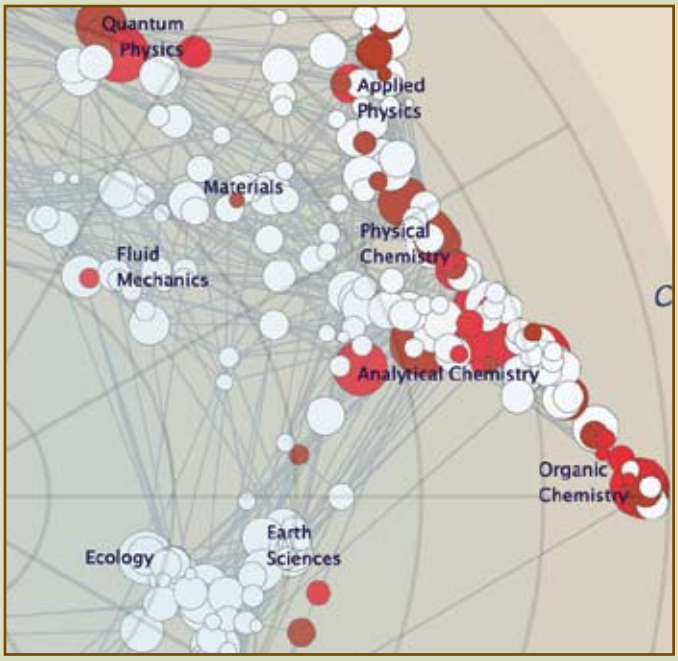
Science of Science Policy

To maintain our nation's global competitiveness, as called for in the ACI, we need a better understanding of society's ability to generate and harness the latest in scientific and technological developments. NSF has begun a wide-ranging inquiry into the social science of science policy, investigating how the national research and development systems work, how to nurture innovation, how to measure science and technology indicators, and how to direct our investments. The long-term goal is to provide science policy makers with the same kinds of analyses and advice that economists now provide for the makers of fiscal and monetary policy. The NSF effort, which has two main components, will be coordinated with similar efforts in several other federal research agencies:

The measurement component seeks to develop a more scientifically rigorous, evidence-based approach to prioritizing research investments, and then monitoring the return on those investments. Research in this area will build upon NSF's already substantial effort in science and engineering statistics—by developing new kinds of measurements and analytical tools, and by forging easy-to navigate links among the databases that already exist, whether in the private sector, in local, state and federal agencies, or internationally.

The research component will seek to achieve an integrated understanding of national and global research and development systems and the process of innovation itself. The intent is to take as broad a view of the process as possible, bringing in perspectives from behavioral science, engineering, economics and virtually every other discipline supported by NSF.

Meanwhile, NSF-funded researchers are developing tools to help individual investigators and science managers navigate through a global knowledge store that is doubling every 18 months or so. A prime example is the fast-emerging field of "mapping science," in which advanced algorithms are used to correlate data from science and engineering databases such as publications, grants, patents and conferences, and to display the information as a two-dimensional map of a scientific area. This approach allows users to drill down to specific information on individual publications. But it also gives them vivid insight into rapidly evolving research areas and the relationships among them.



Detail from a "map" of topics in the 820,000 most-referenced journal articles of 2003 reveals converging interests and connections.

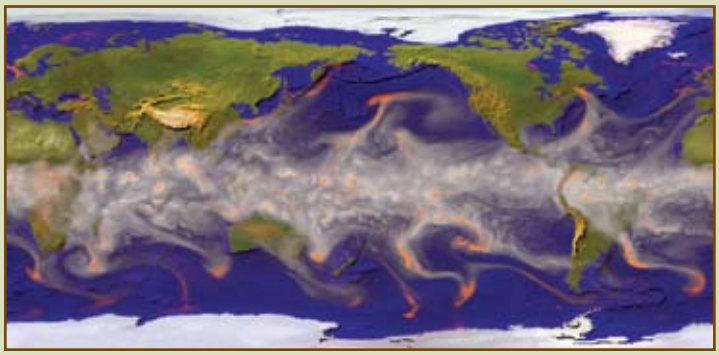
of employees, to enhance recognition of their achievements, and to provide employees with career development opportunities to meet future workforce requirements and challenges.

- ***Enhance NSF as a learning organization.*** NSF will provide continuing education, process enhancements, and opportunities to share best practices to enable continuous improvement. NSF will continue to be a great place to work and a model Equal Employment Opportunity (EEO) agency.
- ***Continue as an exemplar in science ethics.*** NSF will utilize standards, establish best practices, and implement institutional changes that maintain and further build public trust in this area.
- ***Improve the transparency, consistency and uniformity of the merit review process.*** NSF will ensure that ad hoc reviewers and panelists have the breadth and expertise for the set of proposals under their consideration, with special attention to the appropriate review of interdisciplinary and multidisciplinary proposals. Successful technologies and techniques will be expanded to aid in assigning proposals to the most appropriate panels. NSF will promote ways to boost the identification and funding of projects with the potential to transform fields of science and engineering research.
- ***Promote award balance and flexibility.*** NSF will identify and implement programmatic process improvements to achieve appropriate balance among proposal success rate, award size and award duration. NSF will encourage proposals with transformational potential, and will provide flexibility to respond to emerging opportunities and needs.
- ***Enhance processes for management and oversight of large facilities.*** NSF will improve its practices in the development, construction and operations of major research equipment and large facilities projects by implementing the revised guidelines outlined in our *Large Facilities Manual.*
- ***Reach out to the various communities we serve, especially through the use of cyberinfrastructure-enabled communications.*** NSF will utilize new information and communications technologies as they become available to achieve our mission and to communicate mission outcomes. NSF will be open and transparent in communications with the public.

Climate Modeling

Understanding climate variability and change is of increasing importance as input for a wide range of national and international decision making. Knowing current and future trends in rainfall, temperature, storm frequency and intensity, snow cover and wind patterns—to name only a few—is critical to a host of social and economic activities, from insurance rates and agricultural production to the availability of drinking water and the spread of infectious disease. Recent advances in understanding the enormously complex interactions among the myriad components of the climate system have given researchers unprecedented insight into weather patterns and their causes. But numerous uncertainties persist. Dozens of possible cause-and-effect relations remain unconfirmed, and important connections between major components of the climate system (for example, the effect of ocean currents on terrestrial wind patterns, or airborne aerosols on cloud reflectivity) are insufficiently understood.

We cannot experiment on the weather; but through simulations with numerical models, scientists can test theories of the relationships between variables. NSF supports sophisticated climate models run on supercomputers that allow researchers to simulate and predict global and regional climate patterns. One of the most ambitious is the Community Climate System Model (CCSM)—a fully coupled, global climate model that provides state-of-the-art computer simulations of the Earth's past, present, and future climate states. The model is funded by NSF with additional support from the Department of Energy, NASA, and NOAA. It is housed at the National Center for Atmospheric Research (NCAR) and serves the broader climate science community. The model's underlying computer code and simulations data are freely available on the Web. As a result, hundreds of specialists at various institutions in the United States and overseas can use CCSM for their climate experiments.



State-of-the-art climate models help researchers to understand and predict global weather patterns and to explore how variables are related.