NSF FY 2013 Budget Request to Congress

The National Science Foundation Act of 1950 (Public Law 81-507) sets forth our mission: ***To promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense.***

*The National Science Foundation Strategic Plan for FY 2011 – 2016, "Empowering the Nation Through Discovery and Innovation," defines our vision: "****a nation that capitalizes on new concepts in science and engineering and provides global leadership in advancing research and education.****"*

For over 60 years, the National Science Foundation (NSF) has had a profound impact on our Nation's innovation ecosystem by funding the transformative, fundamental research that has become the agency's hallmark. Just as previous NSF investments in fundamental research have led to path-breaking societal advances, from barcodes to web browsers and search engines, NSF's continuing commitment to supporting a wide range of fields and disciplines helps to secure and sustain U.S. competitiveness and economic growth. Similarly, NSF's strong support for science, technology, engineering, and mathematics (STEM) education at all levels provides the nation with a globally-competitive workforce.

NSF's FY 2013 Request reflects wise stewardship of federal funding through innovative, targeted investments that closely align with both agency and Administration priorities. It totals $7.373 billion, an increase of $340.0 million (4.8 percent) over the FY 2012 Estimate, consistent with the Administration's commitment to doubling funding for NSF and other key basic research agencies.

The Request emphasizes the myriad of ways that fundamental research can contribute directly to addressing national challenges:

- Fostering the development of a clean energy economy.
- Supporting future job creation through advanced manufacturing and emerging technologies.
- Protecting critical infrastructure.
- Promoting multidisciplinary research in new materials, wireless communications, cyberinfrastructure, and robotics.
- Developing the next generation of scientific leaders through support for graduate fellowships and early career faculty.
- Advancing evidence-based reforms in science and mathematics education.

At the same time, the request reflects a rigorous prioritization of activities across the Foundation. Approximately $67 million in lower priority education, research, and outreach programs are terminated or consolidated.

These priorities are coupled with NSF's continuing commitment to supporting a broad base of investments in fundamental research and education. As shown below, the Request emphasizes investments made through NSF's two principal accounts: Research and Related Activities (R&RA) and Education and Human Resources (EHR), which support NSF's core programs in fundamental research, human capital development, and the infrastructure needed to pursue learning and discovery at the frontiers of science and engineering.

- In FY 2013, an estimated $3.2 billion is provided for core fundamental research grant programs in R&RA and EHR.
- FY 2013 funding for Major Research Equipment and Facilities Construction (MREFC) fully funds established commitments to ongoing major facility construction projects.
- Support for Agency Operations and Award Management (AOAM) is at the FY 2012 level, which will allow NSF to sustain critical agency operations and address key workload challenges while achieving efficiencies and reducing administrative costs, consistent with Administration-wide efforts.

NSF Funding by Account

(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over FY 2012 Estimate Amount	Change Over FY 2012 Estimate Percent
Research & Related Activities	$5,608.38	$5,689.00	$5,983.28	$294.28	5.2%
Education & Human Resources	861.04	829.00	875.61	46.61	5.6%
Major Research Equipment & Facilities Construction	125.37	197.06	196.17	-0.89	-0.4%
Agency Operations & Award Management	299.29	299.40	299.40	-	-
National Science Board	4.47	4.44	4.44	-	-
Office of Inspector General[1]	14.00	14.20	14.20	-	-
Total, NSF	**$6,912.55**	**$7,033.10**	**$7,373.10**	**$340.00**	**4.8%**

Totals may not add due to rounding.

[1] FY 2011 Actual includes $82,946 of obligations funded through the American Recovery and Reinvestment Act of 2009 (ARRA).

OneNSF Framework

A major emphasis in FY 2013 is the OneNSF Framework, which aims to enable seamless operations across organizational and disciplinary boundaries. OneNSF empowers the Foundation to respond to new challenges in a changing global environment, leverage resources and opportunities for maximum impact, and provide leadership to establish innovative practices, programs, and paradigms that advance scientific knowledge and science, technology, engineering, and mathematics (STEM) education.

FY 2013 OneNSF Framework Priorities

(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request
Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS)[1]	-	141.65	257.42
Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21)	-	78.00	106.08
Expeditions in Education (E^2)	-	-	49.00
NSF Innovation Corps (I-Corps)	1.06	7.50	18.85
Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE)	-	20.35	63.00
Secure and Trustworthy Cyberspace (SaTC)[1]	-	111.75	110.25
Science, Engineering, and Education for Sustainability (SEES)[1]	87.96	157.00	202.50
Total, NSF	**$89.02**	**$516.25**	**$807.10**

Totals may not add due to rounding.

[1] The FY 2011 number shown above for SEES, and the FY 2012 numbers for CEMMSS, SaTC, and SEES, represent estimated levels for directly related activities in these areas.

In FY 2013, the OneNSF Framework encompasses a set of investments that create new knowledge, stimulate discovery, address complex societal problems, and promote national prosperity. Priorities include:

- **Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS)** ($257.42 million) will transform static systems, processes, and edifices into adaptive, pervasive "smart" systems with embedded computational intelligence that can sense, adapt, and react. The smart systems of tomorrow, created through CEMMSS, will vastly exceed those of today in terms of adaptability, autonomy, functionality, efficiency, reliability, safety, and usability. CEMMSS plays a key role in NSF's growing portfolio of advanced manufacturing investments.

- **Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21)** ($106.08 million) aims in FY 2013 to more deeply address a highly science-driven integration of cyberinfrastructure (CI), supporting development of new statistical, mathematical, and computational methods, algorithms, and tools, as well as the cultivation of the next generation of computational and data-enabled researchers who prototype, develop, and use CI in all disciplines.

- **Expeditions in Education (E^2)** ($49.0 million) establishes a partnership between the Directorate for Education and Human Resources (EHR) and other research directorates and offices. E^2 will integrate, leverage, and expand STEM education research and development to improve learning in science and engineering disciplines and capitalize on the scientific assets across NSF to enhance EHR investments in learning and education.

- **NSF Innovation Corps (I-Corps)** ($18.85 million), launched in FY 2011, will continue to establish opportunities to assess the readiness of emerging technology concepts for transitioning into valuable new products through public-private partnerships. I-Corps will bring together technological, entrepreneurial, and business know-how to move discoveries toward commercialization.

- **Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE)** ($63.0 million) integrates NSF's existing interdisciplinary efforts with a suite of new Foundation-wide activities. INSPIRE encourages research that involves multiple disciplines, connects disciplines, or creates new disciplines. It aims to widen the pool of prospective discoveries that may be overlooked by traditional mechanisms.

- The **Secure and Trustworthy Cyberspace (SaTC)** ($110.25 million) investment aligns NSF's cybersecurity investments with the four thrusts outlined in the December 2011 national cybersecurity strategy, *Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity Research and Development Program*. SaTC directly addresses the critical Administration priority of cybersecurity issues by supporting research that seeks to protect the Nation's critical information technology infrastructure, including the Internet, from a wide range of threats that challenge its security, reliability, availability, and overall trustworthiness.

- **Science, Engineering, and Education for Sustainability (SEES)** ($202.50 million) focuses on targeted programs that promote innovative interdisciplinary research to address pressing societal issues of clean energy and sustainability. In FY 2013, SEES includes five programs that are consistent with the SEES long-term vision: Coastal SEES; Arctic SEES; Sustainable Chemistry, Engineering, and Materials (SusChEM); Creating a More Disaster-Resilient America (CaMRA); and a program on the Role of Information Sciences and Engineering in SEES (RISES).

In addition to the OneNSF Framework investments, NSF's multifaceted portfolio will continue to advance all fields of science and engineering and educate the workforce of tomorrow. A few key highlights:

- **Clean Energy** ($355.38 million): NSF's clean energy investments include research related to sustainability science and engineering, such as the conversion, storage, and distribution of diverse power sources (including smart grids), and the science and engineering of energy materials, energy use, and energy efficiency.

- **Advanced Manufacturing** ($148.90 million): Advanced manufacturing research invests in emerging technologies that promise to create high quality manufacturing jobs and enhance our global competitiveness. As noted above in the discussion on CEMMSS, these investments are directly linked to research in areas of national importance such as cyber-physical systems and advanced robotics research; materials processing and manufacturing; and advanced semiconductor and optical device design. Investments in advanced manufacturing are found throughout NSF's portfolio, in activities such as Nanoscale Science and Engineering Centers (NSECs), the National Nanotechnology Initiative (NNI), and the Small Business Innovation Research/Small Business Technology Transfer programs (SBIR/STTR).

- **The Faculty Early Career Development program (CAREER)** ($216.49 million) develops the future scientific and technical workforce through support of young faculty who are dedicated to integrating the research with teaching and learning. In FY 2013, NSF will support approximately 40 more CAREER awards than in FY 2012, for a total of 440 new awards. The CAREER portfolio includes projects that range across all fields of science and engineering supported by the Foundation, including high priority fields such as clean energy, climate change, STEM education, and cybersecurity.

- **The Graduate Research Fellowship program (GRF)** ($242.98 million) supports the development of students and early-career researchers in order to cultivate the next generation of STEM professionals. In FY 2013, 2,000 new fellowships will be awarded, maintaining the doubling of new fellowship awards achieved in FY 2010. To address inflationary pressures on the long-stagnant GRF stipend level, the FY 2013 Request increases the stipend to $32,000.

- **Science and Technology Centers (STCs)** ($74.39 million total for all cohorts) in FY 2013, a new cohort of STCs is initiated ($25.0 million) that will continue the tradition of conducting world-class research through partnerships among academic institutions, national laboratories, industrial organizations, and/or other public/private entities**,** and via international collaborations. STCs provide an innovative way for researchers to conduct investigations at the interfaces of disciplines and to invest in high-risk, potentially transformative science.

- **Research at the Interface of the Biological, Mathematical, and Physical Sciences (BioMaPS*)*** ($30.17 million), is a collaboration among the Directorates for Biological Sciences, Engineering, and Mathematical and Physical Sciences that aims to accelerate the understanding of biological systems, and then apply that knowledge into fundamental understanding and new technologies, particularly clean energy.

- **Experimental Program to Stimulate Competitive Research (EPSCoR)** ($158.19 million) assists NSF in its mandate to promote scientific progress nationwide. EPSCoR effects lasting improvements in the research capacity of institutions in participating jurisdictions to promote broader engagement at the frontiers of discovery and innovation in science and engineering.

- **Enhancing Access to the Radio Spectrum (EARS)** ($50.50 million), begun in FY 2012, continues to partner the Directorates for Engineering, Computer and Information Science and Engineering, Mathematical and Physical Sciences, and Social, Behavioral, and Economic Sciences in supporting the basic research that funds research and development of spectrum-sharing technologies.

- **US Ignite** ($10.0 million) leverages NSF's mid-scale research infrastructure investment in the Global Environment for Network Innovations (GENI). US Ignite provides a unique, at-scale, network testbed for foundational research in networking, distributed systems, cloud computing, and security and for public sector gigabit application development, (i.e., in areas such as advanced manufacturing, health, education, energy, transportation, public safety and emergency preparedness), especially those applications not possible to deploy on today's Internet.

- **Science, Technology, Engineering, and Mathematics (STEM) Education:**
  - **K-16 Math Education:** As part of the nation's strategic plan in STEM education, NSF is partnering with the Department of Education (ED) to launch an evidence-based initiative to improve K-16 mathematics education and knowledge building. This new endeavor will support researchers and educators who have the greatest potential to transform mathematics learning. In FY 2013, NSF's Directorate for Education and Human Resources (EHR) and ED will each

contribute $30.0 million. EHR's contributions will be through support for the Discovery Research K-12 (DR K-12), and Transforming Undergraduate Education in STEM (TUES) programs.

- In FY 2013, the **Widening Implementation and Demonstration of Evidence-based Reforms (WIDER) program** ($20.0 million) will fund research and demonstration projects exploring how to achieve widespread sustainable implementation of evidence-based undergraduate instructional practices to improve student outcomes.

- **Transforming Undergraduate Education in STEM (TUES)** ($61.46 million) aims to improve the quality of STEM education for all undergraduate students by supporting efforts to create, adapt, and disseminate new learning materials and teaching strategies to reflect advances both in STEM disciplines and in what is known about teaching and learning.

- **Federal Cyber Service: Scholarship for Service (SFS)** ($25.0 million) seeks to increase the number of qualified students entering the fields of information assurance and computer security and to increase the capacity of the United States higher education enterprise to continue to produce professionals in these fields to meet the needs of our increasingly technological society. SFS directly addresses the Nation's increasing need for innovative solutions to potential cybersecurity concerns.

Major Research Equipment and Facilities Construction

In FY 2013, NSF will continue construction of four projects: the Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO), the Advanced Technology Solar Telescope (ATST), the National Ecological Observatory Network (NEON), and the Ocean Observatories Initiative (OOI).

All of the projects in the MREFC account undergo major cost and schedule reviews, as required by NSF guidelines.

- **Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO).** A planned upgrade of the existing Laser Interferometer Gravitational-Wave Observatory (LIGO), AdvLIGO will be ten times more sensitive, powerful enough to approach the ground-based limit of gravitational-wave detection.

- **Advanced Technology Solar Telescope (ATST).** ATST will enable study of the sun's magnetic fields, which is crucial to our understanding of the types of solar variability and activity that affect Earth's civil life and may impact its climate.

- **National Ecological Observatory Network (NEON).** NEON will consist of geographically distributed field and lab infrastructure networked via cybertechnology into an integrated research platform for regional to continental scale ecological research.

- **Ocean Observatories Initiatives (OOI).** OOI will enable continuous, interactive access to the ocean via multiple types of sensors linked by cutting-edge cyberinfrastructure, which will produce never-before-seen views of the ocean's depths.

MREFC Account Funding, by Project
(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request
Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO)	$23.58	$20.96	$15.17
Atacama Large Millimeter Array (ALMA)	13.92	3.00	-
Advanced Technology Solar Telescope (ATST)	5.00	10.00	25.00
IceCube Neutrino Observatory	5.29	-	-
National Ecological Observatory Network (NEON)	12.58	60.30	91.00
Ocean Observatories Initiative (OOI)	65.00	102.80	65.00
Total, MREFC	**$125.37**	**$197.06**	**$196.17**

Totals may not add due to rounding.

Model Organization

To "Perform as A Model Organization" (Model Organization), one of NSF's three strategic goals, is an internally focused goal that emphasizes the agency's desired outcome of attaining excellence in all aspects of its operations. Model Organization underpins NSF programmatic activities and encompasses all the agency's management activities. It also includes support for the activities of the Office of Inspector General (OIG) and the National Science Board (NSB), which are provided in separate appropriations.

Workforce
The FY 2013 Budget Request includes $209.47 million, or $6.56 million over the FY 2012 Estimate, for funding NSF's federal workforce. The Request will support 1,352 regular full-time equivalents (FTE), an increase of 25 over the FY 2012 Estimate allocation of 1,327 FTE.

iTRAK
FY 2013 is the first year of iTRAK implementation. iTRAK will transition NSF from its legacy financial and property management systems to a fully integrated financial management solution. In FY 2013, the total request for iTRAK is $11.70 million.

Promoting Efficient Spending
In conjunction with the President's efforts to reduce spending across several administrative areas, NSF has launched its own efficiency initiative to strengthen operations and management and to increase accountability and responsibility for the resources entrusted to it. This effort will entail streamlining administrative and programmatic business practices to reduce and avoid costs and identifying common sense approaches to achieve savings where possible. In response to Executive Order 13589, *Promoting Efficient Spending*, NSF is planning to reduce spending by $18.90 million in FY 2013. This reduction goal represents a 20 percent reduction below actual FY 2010 levels in areas targeted government-wide for savings and efficiencies. These efforts to reduce administrative costs will require an aggressive review and prioritization of current activities so that funds are devoted to the most critical aspects of NSF's operations.

Model Organization by Appropriations Account
(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	FY 2013 Request Change over FY 2012 Estimate Amount	Percent
Agency Operations and Award Management	$299.29	$299.40	$299.40	-	-
Office of Inspector General[1]	14.00	14.20	14.20	-	-
National Science Board	4.47	4.44	4.44	-	-
Research & Related Activities	89.19	94.12	94.75	0.63	0.7%
Education and Human Resources	15.19	15.39	15.48	0.09	0.6%
Subtotal, Program Support	104.39	109.51	110.23	0.72	0.7%
Total	**$422.14**	**$427.55**	**$428.27**	**$0.72**	**0.2%**

Totals may not add due to rounding.

[1] FY 2011 Actual includes $82,946 of obligations funded through the American Recovery and Reinvestment Act of 2009 (ARRA).

Evaluation and Performance

NSF embraces the use of goals to drive performance improvements. For FY 2012 – FY 2013, NSF has established the following three priority goals, in keeping with the GPRA Modernization Act (P.L. 111-352).

Priority Goal: Access to Digital Products of NSF-Funded Research
NSF has set a goal to establish policies for public access to high-value data and software in at least two data-intensive scientific domains. Digital data are increasingly one of the primary products of scientific research, and should be accessible and linked to one another so that scientists can verify and reproduce major findings in the literature and repurpose the data to enable new discoveries. Simultaneously, access to digital products of research enhances openness and transparency in the scientific enterprise and enables new types of multi-disciplinary research and education. The priority goal supports this vision of increasingly collaborative and multi-disciplinary science by assuring that knowledge and data can flow easily across traditional disciplinary boundaries.

Priority Goal: Undergraduate Programs
As part of NSF's long-term core commitment to develop a diverse and highly qualified science and technology workforce, NSF will measure the percent of institutions funded through NSF undergraduate programs that document the extent to which they use proven instructional practices. The FY 2013 goal is to reach 80 percent. Research shows that evidence-based instructional practices lead to improved student learning, and thus are a useful metric for assessing impact on a well-prepared workforce. One way that NSF can advance its efforts to invest in the preparation of a strong science and engineering workforce is by encouraging and facilitating the use of empirically-based instructional practices in undergraduate science, technology, engineering, and mathematics (STEM) education.

Priority Goal: NSF Innovation Corps
NSF has set a priority goal to increase the number of entrepreneurs emerging from university laboratories. Through the NSF Innovation Corps (I-Corps) program, NSF seeks to accelerate the development of new technologies, products, and processes that arise from fundamental research. With I-Corps, NSF supports NSF-funded researchers whose efforts will be augmented – in the form of mentoring and funding – to accelerate the translation of knowledge derived from fundamental research into emerging products and services that can attract subsequent third party funding. NSF investments will strategically strengthen the innovation ecosystem by addressing the challenges inherent in the early stages of the innovation process. NSF will track achievement of this goal by measuring the percent of I-Corps teams that have tested the commercial viability of the product or service. The FY 2013 goal is to achieve 80 percent.

Please refer to Performance.gov for information on Federal Priority Goals and NSF's contributions to those goals.

Cuts, Consolidations, and Savings

NSF's FY 2013 Request follows a thorough examination of programs and investments across NSF to determine where the potential exists for more innovative investments.

This Request includes eleven recommended cuts and consolidations, totaling $67.0 million. These are described here, including: elimination of three Computer and Information Science and Engineering Research Programs; termination of the Cyber-enabled Discovery and Innovation (CDI) program; elimination of four Mathematics and Physical Sciences Research Programs; reduced funding for Nanoscale Science & Engineering Centers (NSECs); and elimination of two public outreach programs.

Computer and Information Science and Engineering Research Programs (-$17.0 million total): Three programs within the Directorate for Computer and Information Science and Engineering (CISE) are eliminated since they have reached their planned endpoints and have achieved their original goals. These programs are: Network Science and Engineering (NetSE) (-$3.0 million); Social-Computational Systems (-$7.0 million); and the Interface between Computer Science and Economic & Social Sciences (ICES) (-$7.0 million). Support for these research areas will be absorbed into CISE core programs.

Cyber-enabled Discovery and Innovation (CDI) (-$29.0 million total): NSF eliminates funding for the agency-wide CDI program, as the program has reached its planned conclusion and has achieved many of its original goals. Funding will be redirected to support new efforts in two NSF cross-agency initiatives (CEMMSS and CIF21) in FY 2013 that will build on the accomplishments made in the CDI program.

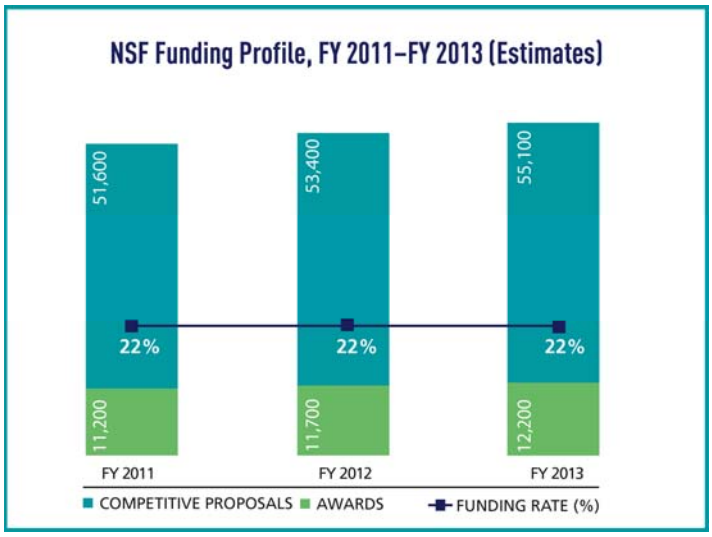
Mathematical and Physical Sciences Research Programs (-$10.0 million total): Four programs within the Directorate for Mathematical and Physical Sciences (MPS) are eliminated because they overlap with larger core disciplinary programs or they have achieved their original goals. Two programs are eliminated as they are no longer needed as stand-alone programs: Mathematical Physics (-$2.0 million) and Grid Computing (-$2.0 million). Research conducted under the third program, Cultural Heritage Science (-$4.0 million), will be funded through regular MPS disciplinary programs. Lastly, the CHE-DMR-DMS Solar Energy Initiative (SOLAR) (-$2.0 million) will be subsumed within the broader framework of NSF's SEES investment through the Sustainable Energy Pathways solicitation.

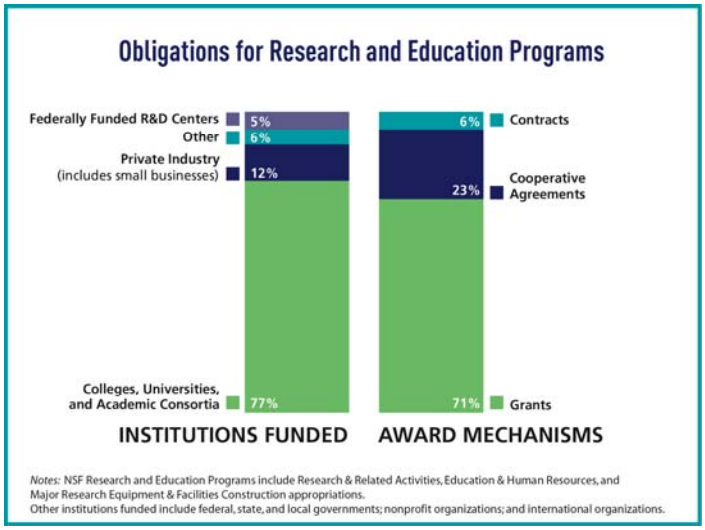
Nanoscale Science & Engineering Centers (NSECs) (-$5.0 million total): NSF reduces support for the NSEC program because the state of the research in this area has matured significantly and the research should advance more rapidly in a different, more use-inspired research center program. Several NSEC grants may transition to the Nanosystems Engineering Research Centers (NERCs) as the nano-devices and processes created at graduating NSECs move to the systems level and potential commercialization. NSF will continue to support eleven continuing NSECs in FY 2013.

Public Outreach terminations (-$6.0 million total): NSF eliminates two small stand-alone public outreach programs because they lack rigorous evaluation and are duplicative of the larger, well-established peer-reviewed Advanced Informal STEM Learning (formerly, Informal Science Education) program. The eliminated programs are: Communicating Science Broadly (-$2.0 million) and Connecting Researchers with Public Audiences (-$4.0 million).

NSF by the Numbers

NSF by The Numbers: In FY 2013 NSF expects to evaluate over 55,000 proposals through a competitive merit review process and make over 12,000 new awards. This will require over 260,000 proposal reviews, engaging on the order of 40,000 to 50,000 members of the science and engineering community participating as panelists and proposal reviewers. In a given year, NSF awards reach nearly 1,900 colleges, universities, and other public and private institutions in 50 states, the District of Columbia, and Puerto Rico. In FY 2013, NSF support is expected to reach approximately 285,000 researchers, postdoctoral fellows, trainees, teachers, and students.



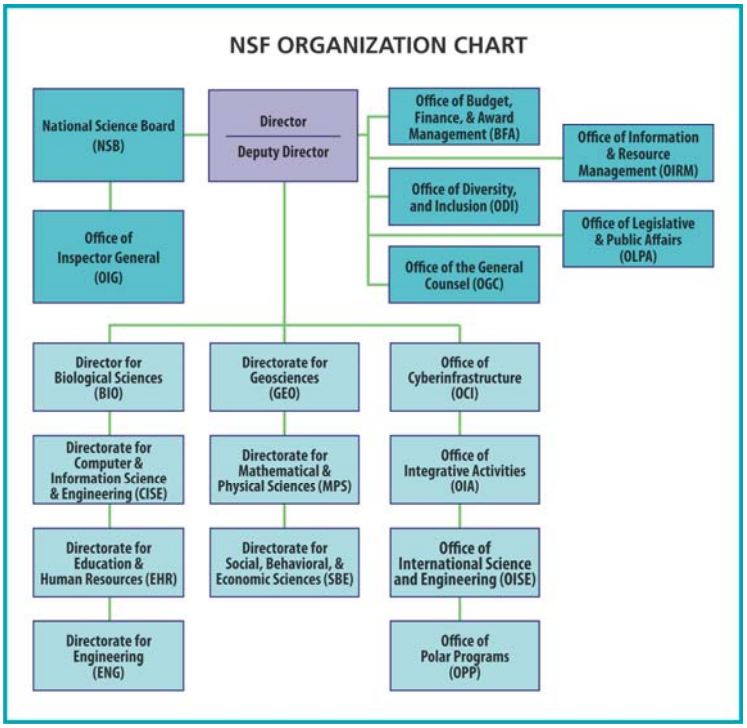


The chart on the left shows the distribution of NSF's obligations by institution type and funding mechanism. While the data are based on FY 2011, the relative shares should provide a good indication of the FY 2013 distribution. As shown on the graph, 94 percent of NSF's FY 2011 projects were funded using grants or cooperative agreements. Grants can be funded either as standard awards, in which funding for the full duration of the project is provided in a single fiscal year, or as continuing awards, in which funding for a multi-year project is provided in increments. Cooperative agreements are used when the project requires substantial agency involvement during the project performance period (e.g., research centers, multi-user facilities, etc.). Contracts are used to acquire products, services, and studies (e.g., program evaluations) required primarily for NSF or other government use.

Most NSF awards are to academic institutions. Nonprofit organizations include state and local governments and international organizations. For-profit businesses include private and small businesses. Federal agencies and laboratories include funding for Federally Funded R&D Centers.

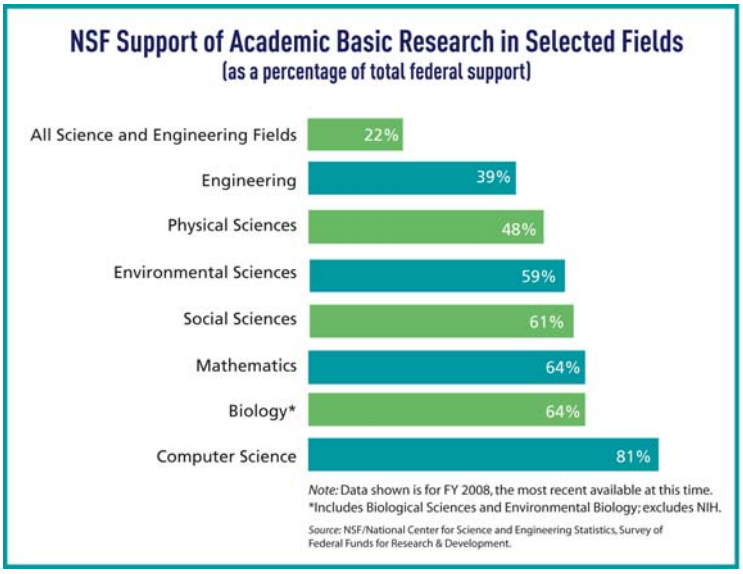
Organization and Role in the Federal Research Enterprise

NSF's comprehensive and flexible support of meritorious projects with broad societal impacts enables the Foundation to identify and foster both fundamental and transformative discoveries within and among fields of inquiry. NSF has the latitude to support emerging fields, high-risk ideas, interdisciplinary collaborations, and research that pushes – and even transforms – the very frontiers of knowledge. In these ways, NSF's discoveries inspire the American public – and the world.

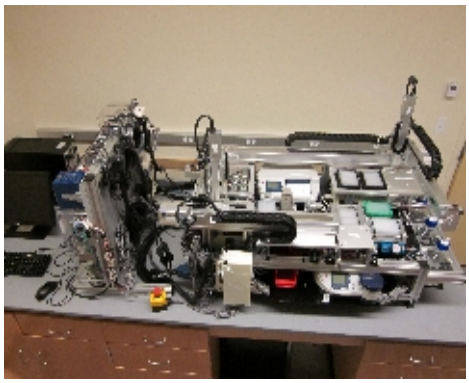


NSF's organization represents the major science and engineering fields, including: biological sciences; computer and information science and engineering; engineering; geosciences; mathematical and physical sciences; and social, behavioral, and economic sciences. NSF also carries out specific responsibilities for education and human resources, cyberinfrastructure, integrative activities, international science and engineering, and polar programs. The 25-member National Science Board sets the overall policies of the Foundation.

NSF's annual budget represents 22 percent of the total federal budget for basic research conducted at U.S. colleges and universities, and this share increases to 61 percent when medical research supported by the National Institutes of Health is excluded. In many fields NSF is the primary source of federal academic support.



Highlights

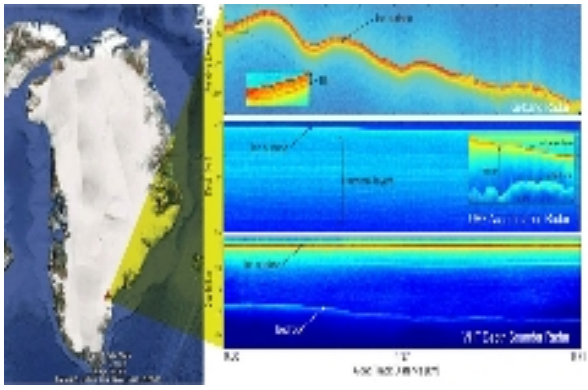


Credit: Dr. Harris Wang, Harvard University

The Design and Evolution of Organisms Through Genome Programming

NSF Graduate Research Fellow Harris Wang invented the Multiplex Automated Genome Engineering (MAGE) platform, an engineering technique that allows researchers to rapidly increase "the design and evolution of organisms with new and improved properties." Engineering bacterial cells by manipulating their genomes is a very slow and laborious process. The MAGE platform allows efficient development of customized microorganisms for bioengineers. MAGE is applied towards solving global challenges by enabling bioengineers to program cells quickly and easily. Examples of the future applications from the lab's research include: production of pharmaceuticals, including artemisinin for malaria treatment, Taxol to fight cancer, and lycopene as an anti-oxidant dietary supplement; production of biofuels such as ethanol, butanol, diesel, and other hydrocarbons; and cell-based therapies.

Multi-Radar Mapping of Polar Ice

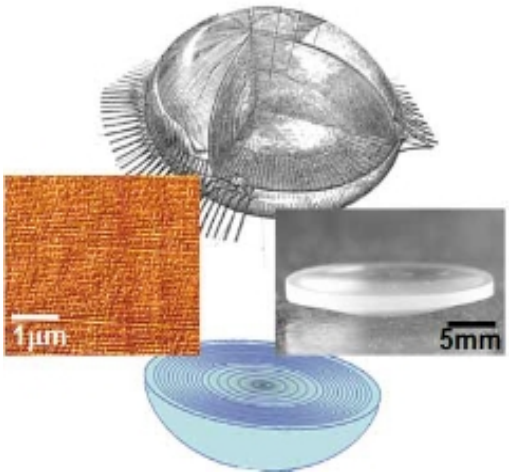


Credit: CReSIS, the University of Kansas; map from Google maps

The NSF-supported Center for Remote Sensing of Ice Sheets (CReSIS) has developed several types of radar (Ku-band radar, ultra high frequency accumulation radar and very high frequency depth sounder) to probe the ice on land and sea in Greenland and Antarctica. Researchers apply advanced signal processing techniques to radar data to create images of the interior structure of the ice sheets and hidden terrain below. The data collected with CReSIS radars provide ice sheet modelers with information essential to developing more accurate estimates of the contributions of the Antarctic and Greenland ice sheets to climate change and to better capture rapid changes currently observed. In the future, the radars will fly on remotely operated aircraft to acquire detailed ice sheet maps at times and places otherwise difficult to cover.

Highlights

Polymer Research Leads to New Commercial Technologies



Credit: Professor Eric Baer, Case Western Reserve University

Cutting-edge research--the result of collaborations within NSF's multi-institution Center for Layered Polymeric Systems (CLiPS) at Case Western Reserve – has led to two new U.S. start-up companies, one dedicated to improving water filtration systems and the other to advances in surveillance systems and solar cell equipment. The first company, Advanced Hydro, seeks to extend the lifetime and cost efficiency of membrane-based water filtration systems. It uses "bio-inspired," multilayer, polymer coatings that interact favorably with water. The second company, PolymerPlus, is dedicated to developing a new class of light-weight, polymer lenses with improved optical performance, to be used in miniaturized surveillance and solar-cell devices. PolymerPlus will use a technique developed by CLiPS that produces films with hundreds or even thousands of layers.

At the Forefront of Cybersecurity Research

From advances in operating systems, software, and hardware to understanding the underlying motives of attacks, NSF-funded research is helping to ensure the security, reliability, availability, and overall trustworthiness of information technology resources. The Team for Research in Ubiquitous Secure Technology (TRUST), established as an NSF Science and Technology Center, is a university and industry consortium that supports cybersecurity research and education. TRUST, led by the University of California Berkeley, addresses technical, operational, privacy, and policy challenges via interdisciplinary projects that combine fundamental science and applied research to deliver breakthrough advances in trustworthy systems. Cybersecurity experiments require secure testbeds, such as the cyber-Defense Technology Experimental Research (DETER) testbed, which provides a safe venue to explore cyber security vulnerabilities since it is isolated from the outside internet.

Credit: DETER Testbed

Highlights

Credit: Zhijian Pei, Kansas State University

Harvesting Fuel from Green Algae

NSF-sponsored researchers at Kansas State University have developed a cost-effective way to harvest renewable fuels from algae grown in the sea, based on observations of algae growth on solid materials. In this technique, algae are restricted from moving and attached to a solid carrier material for growth. Immobilizing the algae increases their concentration at harvest and eases extraction of the generated fuel. The researchers studied four different types of materials for algae immobilization and found that different species of green algae favor different solid carrier materials. Their research will allow for future advances to overcome the challenges of harvesting large quantities of algae as an alternative energy source.

Mesoporous Material Transforms Solar Energy Into Fuel

A research team in South Dakota has developed a method to rapidly create a novel material that generates hydrogen in the presence of water and sunlight. This research expands our understanding of how to generate fuel using visible sunlight rather than ultraviolet light. Because the hydrogen generation occurs at room temperature, the process will easily scale up to large production volumes. Applications of the new material range from removal of carbon dioxide from the atmosphere to the mitigation of environmental pollution.

Credit: Ranjit T. Koodali
University of South Dakota

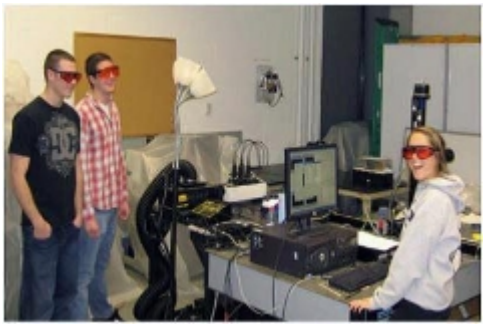
Credit: Andrew Whitehead

Gulf of Mexico Deepwater Horizon Spill Effects on Fish Revealed

Despite low concentrations of oil constituents in Gulf of Mexico waters from the Deepwater Horizon spill, fish were dramatically affected by toxic components of the oil. So found a team led by scientists Fernando Galvez and Andrew Whitehead of Louisiana State University (LSU). Galvez, Whitehead and colleagues undertook a combined field and laboratory study. It showed widespread effects of the Deepwater Horizon oil spill on fish in Louisiana marshes. Gene expression in tissues of the fish studied--in this case killifish--was predictive of oil spill responses such as developmental abnormalities and death, say the biologists. "It also indicated impairment of fish reproduction," says Whitehead. The study was funded by a National Science Foundation (NSF) rapid response grant.

Highlights

Wind Tunnel Gives Students Hands-on Design Experience



Credit: Martin Wosnik, University of New Hampshire

Teams of University of New Hampshire undergraduate students designed and built the supporting infrastructure for the Flow Physics Facility, the world's largest boundary layer wind tunnel. Projects included a three-meter diameter computer-controlled turntable, a prototype drag plate to measure surface skin friction in the tunnel, and hot-wire sensors with a measurement volume of half a millimeter. The wind tunnel will advance our understanding of the high Reynolds number boundary layers that are present on ships and aircraft, and are the primary contributor to drag.

Global Education, Awareness, and Research Undergraduate Program

Credit: Lorraine N. Fleming, Howard University

Twenty-four Howard University engineering students are conducting research jointly with students from six universities in Africa, South America and Southeast Asia. Research mentors are faculty from Howard and from the six host universities-Ateneo de Manila University (Philippines); Bahir Dar University (Ethiopia); Universidad Andrés Bello (Chile); Université Cheikh Anta Diop (Sénégal); University of Indonesia; and University of Nairobi (Kenya). The results of the research will broaden the Howard University engineering curriculum, with an infusion of global engineering topics into a number of courses, including senior capstone design. Some examples of the engineering problems that Howard students are studying are: challenges of water treatment plants in Nairobi, traffic jams in Jakarta, flooding of the Blue Nile in Ethiopia, and earthquakes in Chile.

Vision Scientists Demonstrate Innovative Learning Method

Credit: Nicolle Rager Fuller, NSF

It may be possible to use brain technology to learn to play a piano, reduce mental stress or hit a curve ball with little or no conscious effort. Experiments conducted at Boston University (BU) and ATR Computational Neuroscience Laboratories in Kyoto, Japan, recently demonstrated that through a person's visual cortex, researchers could use decoded functional magnetic resonance imaging (fMRI) to induce brain activity patterns to match a previously known target state and thereby improve performance on visual tasks. The National Science Foundation, the National Institutes of Health and the Ministry of Education, Culture, Sports, Science and Technology in Japan supported the research.

Highlights

First Global Picture of Greenhouse Gases Emerges from Pole-to-Pole Research Flights

Credit: Carlye Calvin, UCAR

A three-year series of research flights from the Arctic to the Antarctic has successfully produced an unprecedented portrait of greenhouse gases and particles in the atmosphere. The far-reaching field project, known as HIPPO (for HIAPER Pole-to-Pole Observations), relies on the capabilities of a specially equipped Gulfstream V aircraft, owned by NSF and operated by NCAR in Boulder, Colo. The research jet (High-performance Instrumented Airborne Platform for Environmental Research or HIAPER) is outfitted with a suite of specially designed instruments to sample a broad range of atmospheric constituents. The team measured a total of more than 80 gases and particles in the atmosphere. One of HIPPO's most significant accomplishments has been quantifying the seasonal amounts of carbon dioxide taken up and released by land plants and the oceans.