NSF FY 2018 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; to secure the national defense..."***

*The National Science Foundation Strategic Plan for 2014-2018, "Investing in Science, Engineering, and Education for the Nation's Future," defines our vision: "**A Nation that creates and exploits new concepts in science and engineering and provides global leadership in research and education."***

The President's FY 2018 Budget Request for the National Science Foundation (NSF) continues the Nation's longstanding commitment to support basic research and education across all fields of science and engineering. NSF funds basic research that pushes the boundaries of innovation and lays the groundwork for scientific breakthroughs that advance our Nation's economy, security, and global leadership. Also critical are NSF's education investments in science, technology, engineering, and mathematics (STEM) fields, which help to prepare future generations of scientists and engineers.

In January 2017, the President signed into law the American Innovation and Competitiveness Act (P.L. 114-329, abbreviated AICA), a bipartisan bill that affirms NSF's long-standing world renowned merit review process. AICA also addresses NSF's implementation of particular issues of importance such as increased transparency and accountability; management of multi-user facilities and mid-scale projects; and increased oversight of major research equipment and facilities. While maximizing research and education opportunities that help create the innovations that fuel our economy and create jobs, AICA also promotes the Foundation's commitment to diversity in STEM fields, incentivizes NSF's programs which encourage private-sector involvement, and re-affirms NSF's continued commitment to entrepreneurship and commercialization.

FY 2018 Budget Request

Total:	$6.65 billion
Decrease:	$840.98 million
-11.2% from FY 2016 Actuals	

NSF's FY 2018 Budget Request is $6.653 billion, a decrease of $840.98 million (-11.2 percent) over the FY 2016 Actual investment. This funding will support approximately 8,000 new research grants, with an estimated funding rate of 19 percent for research grant proposals submitted to NSF. For comparison, in FY 2016, NSF funded 8,800 new research grants, with a funding rate of 21 percent.

The FY 2018 Budget Request reflects NSF's commitment to establishing clear priorities in areas of national importance, as well as to identifying innovative and promising research ideas, in order to yield return on investment for the Nation.

Federal investments in basic research and STEM workforce development are increasingly important to help establish U.S. leadership in next-generation technologies, especially as other nations intensify their support of research, development, and education. U.S. leadership is important, in part because of the unprecedented level of global competition for the highly skilled, technical workers who generate innovative scientific ideas.

As the only agency with a diverse portfolio that supports all fields of science and engineering, NSF helps to cultivate the Nation's role as a leader in the scientific enterprise by supporting the fundamental research that is so vital to the commercial marketplace and by building the workforce necessary to address the complex challenges that face the Nation.

NSF's Big Ideas

In 2016, NSF unveiled a set of "Big Ideas"—10 bold, long-term research ideas that identify areas for future investment at the frontiers of science and engineering. With its broad portfolio of investments, NSF is uniquely suited to advance this set of cutting-edge research agendas and processes that will require collaborations with industry, private foundations, other agencies, science academies and societies, and universities and the education sector. The Big Ideas represent unique opportunities to position our Nation at the cutting edge—indeed to define that cutting edge—of global science and engineering leadership and to invest in basic research that advances the United States' prosperity, security, health, and well-being.

NSF remains firmly committed to the Big Ideas, which are at different levels of readiness. The FY 2018 Budget Request to Congress details a variety of activities related to the Big Ideas that (1) continue the investment in developing the research foundations, including piloting select new programs; (2) build capacity in the research community, and (3) support the community-wide visioning and planning that will be crucial for effective implementation in the future. Together, these FY 2018 activities position NSF, and the Nation's research community, to move toward realizing the vision and potential of the Big Ideas.

Six of the Big Ideas are research ideas, which build on a foundation made possible by earlier investments in fundamental research.

- **Harnessing the Data Revolution—**Engaging NSF's research community in the pursuit of fundamental research in data science and engineering, the development of a cohesive, federated, national-scale approach to research data infrastructure, and the development of a 21st-century data-capable workforce.

- **Work at the Human Technology Frontier: Shaping the Future—**Understanding how constantly evolving technologies are actively shaping the lives of workers and how people in turn can shape those technologies, especially in the world of work.

- **Windows on the Universe: The Era of Multi-messenger Astrophysics—**Using powerful new syntheses of observational approaches to provide unique insights into the nature and behavior of matter and energy and help to answer some of the most profound questions before humankind.

- **The Quantum Leap: Leading the Next Quantum Revolution—**Exploiting quantum mechanics to observe, manipulate, and control the behavior of particles and energy at atomic and subatomic scales, resulting in next-generation technologies for sensing, computing, modeling, and communicating.

- **Understanding the Rules of Life: Predicting Phenotype—**Elucidating the sets of rules that predict an organism's observable characteristics, its phenotype.

- **Navigating the New Arctic—**Establishing an observing network of mobile and fixed platforms and tools across the Arctic to document and understand the Arctic's rapid biological, physical, chemical, and social changes.

Four of the Big Ideas are process ideas, which address NSF practices that could be altered or enhanced to capture the best research and to welcome new members to the science community.

- **Mid-scale Research Infrastructure—**Developing an agile process for funding experimental research capabilities in the mid-scale range.

- **NSF 2026: Seeding Innovation—**Investing in bold foundational research questions that are large in scope, innovative in character, originate outside of any particular directorate, and require a long-term commitment. This Big Idea is framed around the year 2026 in order to tie into the Nation's 250th anniversary ("sestercentennial").

- **NSF INCLUDES (Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science): Enhancing Science and Engineering through Diversity—**Transforming education and career pathways to help broaden participation in science and engineering.

- **Growing Convergent Research at NSF—**Framing challenging research questions at inception, and fostering the collaborations needed for successful inquiry.

FY 2018 NSF-Wide Investments

NSF continues to bring together researchers from all fields of science and engineering to address today's cross-disciplinary questions and challenges through Foundation-wide activities. In FY 2018, NSF continues to support seven continuing cross-Foundation investments.

FY 2018 Funding for Ongoing NSF-Wide Investments

(Dollars in Millions)

	FY 2016 Actual	FY 2017 (TBD)	FY 2018 Request	Change Over FY 2016 Actual Amount	Change Over FY 2016 Actual Percent
Cyber-Enabled Materials, Manufacturing	$271.52	-	$222.43	-$49.09	-18.1%
Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (NSF INCLUDES)	13.97	-	14.88	0.91	6.5%
Innovations at the Nexus of Food, Energy, and Water Systems (INFEWS)	80.10	-	24.40	-55.70	-69.5%
NSF Innovation Corps (I-Corps™)	29.74	-	26.15	-3.59	-12.1%
Risk and Resilience	42.94	-	31.15	-11.79	-27.4%
Secure and Trustworthy Cyberspace (SaTC)	129.78	-	113.75	-16.03	-12.3%
Understanding the Brain (UtB)	172.75	-	134.46	-38.29	-22.2%

Several of these NSF-wide Investments are reduced over the FY 2016 Actual investment. NSF's commitment to these areas remains strong as the fundamental research programs across the agency will continue to invest in the basic research that advances these specific focus areas.

Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS) ($222.43 million) aims to integrate science and engineering activities across NSF, including breakthrough materials, advanced manufacturing, and smart systems, which include robotics and cyber-physical systems. Research has led to discoveries of materials with unique properties and functionality that can be developed more reliably and efficiently via the integration of theory, modeling and simulation, data analytics, and experimentation. The integration of advanced materials with capabilities of intelligence is transforming static systems, processes, and edifices into adaptive, pervasive, and smart systems. These smart systems will be able to act independently and intelligently in dynamic, uncertain, and unanticipated environments. They will contribute to advanced manufacturing and have the potential to accelerate scientific and engineering discoveries to address key national and societal challenges critical to U.S. security and competitiveness. In FY 2018, CEMMSS will focus on increasing integration of the highest priority areas such as those related to materials and manufacturing, and developing smart systems.

Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (NSF INCLUDES) ($14.88 million) is an integrated, national initiative to increase the preparation, participation, advancement, and potential contributions of those who have been traditionally underserved or underrepresented in the science, technology, engineering, and mathematics (STEM) enterprise. Providing opportunities and support for members of all communities and sectors across the United States is necessary for the Nation's economic welfare and as part of NSF's commitment to equity. Investments aim to produce measurable, sustainable progress at the national level and to scale effective approaches to diversity and inclusion in STEM. NSF INCLUDES is one of NSF's 10 Big Ideas.

Innovations at the Nexus of Food, Energy, and Water Systems (INFEWS) ($24.40 million) aims to understand, design, and model the interconnected food, energy, and water system through an interdisciplinary research effort that incorporates all areas of science and engineering and addresses the natural, social, and human-built factors involved. INFEWS, however, is the first program to study the interconnected food-energy-water nexus. This program is driven by pressing needs and challenges, such as growing U.S. and global populations, changes in land use, and increasing geographic and seasonal variability in precipitation patterns, all of which are placing an ever-increasing stress on these critical resources. NSF, through INFEWS, is uniquely poised to focus not only on the fundamental science and engineering questions at this nexus, but to train the next generation of researchers in this interdisciplinary area.

NSF Innovation Corps (I-Corps™) ($26.15 million) improves NSF-funded researchers' access to resources that can assist in bridging the gap between discoveries and technologies, helping to transfer knowledge to downstream technological applications and use at scale. In FY 2018, NSF will continue to support I-Corps™ Nodes and I-Corps™ Sites to further build, utilize, and sustain a national innovation ecosystem that helps researchers effectively identify viable market opportunities and augments the development of technologies, products, and processes that benefit the Nation.

Risk and Resilience investments ($31.15 million) aim to improve predictability and risk assessment and increase preparedness for extreme natural and man-made events in order to reduce their impact on quality of life, society, and the economy. In FY 2018, Prediction of and Resilience against Extreme Events (PREEVENTS) and the Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP) program will continue, along with other contributing activities. PREEVENTS is a focused research effort that will help to better understand and mitigate the risks posed to the U.S. by natural hazards. The CRISP program will promote research on Interdependent Critical Infrastructures (ICI) systems and processes and educate the next generation of scientists and engineers in how to best improve the resilience of our infrastructures in the face of changing and increasing risks. The projects supported will make ICI services more effective, efficient, dependable, adaptable, resilient, safe, and secure.

The **Secure and Trustworthy Cyberspace (SaTC)** ($113.75 million) investment aims to build the knowledge base in cybersecurity that enables discovery, learning, and innovation, and leads to a more secure and trustworthy cyberspace. Through a focus on long-term, foundational research, SaTC will develop the scientific foundations for cybersecurity research for years to come. SaTC also focuses on the training of the next generation cybersecurity workforce, especially for government. SaTC aligns NSF's cybersecurity investments with the national cybersecurity strategy.

Understanding the Brain (UtB) ($134.46 million) encompasses ongoing cognitive science and neuroscience research and NSF's contributions to the ongoing Brain Research through Advancing Innovation and Neurotechnologies (BRAIN) Initiative. The goal of UtB is to enable scientific understanding of the full complexity of the brain, in action and in context. There remains much to discover to attain a comprehensive understanding of the general principles underlying how cognition and behavior relate to the brain's structural organization and dynamic activities; how brain, behavior, and environment interact; and how the brain can recover from lost functionality.

Additional Highlights

- NSF fully funds the construction of three **major research equipment and facilities projects** ($182.80 million). Funding these projects is an essential part of the science and engineering enterprise that enables science to advance in ways that would not otherwise be possible. These three projects include the following: The Daniel K. Inouye Solar Telescope, which will be the world's most powerful ground-based solar telescope and will enable astronomers to gain new insights into solar phenomena; The Large Synoptic Survey Telescope, which will produce the deepest, widest image of the universe; Regional

Class Research Vessels, a major component in the plan for modernizing the U.S. Academic Research Fleet.

- NSF is responsible for the management of **polar facilities and logistics** ($284.96 million). Operational support in the Arctic and the Antarctic plays an indispensable role in allowing the international research community to carry on their work in these regions. The United States is a leading nation in polar science, and research results have global significance.

- Cutting-edge, NSF-supported research—as well as education and workforce development programs—are helping to assist in areas of national priority, such as **cybersecurity and advanced manufacturing** ($144.50 million and $173.33 million, respectively). NSF investments in these areas have helped to develop innovative ways to secure information and ensure privacy on the Internet, as well as to improve the manufacturing sector's improve its efficiency, competitiveness, and sustainability.

- The **National Strategic Computing Initiative (NSCI)** was established to advance national leadership in High-Performance Computing (HPC) and maximize the benefits of HPC for scientific discovery and economic competitiveness. Under NSCI, NSF will support research advances in new computing technologies, architectures, and platforms for the future, as well as the development and deployment of advanced HPC systems, including maximizing their benefits through deep integration of HPC cyberinfrastructure with science and engineering research. NSF is one of three lead agencies for NSCI, with the Department of Defense and the Department of Energy.

- In FY 2018, NSF will continue investments to extend the frontiers of **high-performance computing** ($60.0 million). This investment will support the acquisition and deployment of a new HPC system that will serve as a national resource for providing predictable and sustained long-term capabilities for science and engineering to push the frontiers of knowledge and ultimately promote the health, prosperity, and welfare of the Nation.

Education and STEM Workforce

NSF's education and STEM workforce investment, centered in the Directorate for Education and Human Resources (EHR), funds activities that support students, teachers, researchers, and the public. The EHR investment in core STEM education research is critical to building the Nation's knowledge base for improving STEM learning. NSF's investments for FY 2018 focus on the following priorities:

- The **CyberCorps®: Scholarship for Service (SfS)** program ($40.0 million, a decrease of $9.98 million) supports cybersecurity education and research at higher education institutions. SFS also focuses on workforce development by increasing the number of qualified students entering the fields of information assurance and cybersecurity, which enhances the capacity of the U.S. higher education enterprise to continue to produce professionals in these fields to secure the Nation's cyberinfrastructure. FY 2018 activities will include engaging first- and second-year undergraduate students, especially veterans.

- **Computer Science for All (CSforAll)** ($20.0 million) will build on ongoing efforts to enable rigorous and engaging computer science education in schools across the Nation. Funds will support the development and assessment of prototype instructional materials, scalable and sustainable professional development models, approaches to preservice preparation for computer science teachers, and teacher resources. CSforAll aims to provide high school teachers with the preparation, professional development, and ongoing support that they need to teach rigorous computer science courses and to give preK-8 teachers the instructional materials and preparation they need to integrate computer science and computation thinking into their teaching.

- The **Improving Undergraduate STEM Education (IUSE)** ($96.50 million, a decrease of $8.27 million) initiative supports the development of the STEM and STEM-capable workforce by investing in the improvement of undergraduate STEM education, with a focus on attracting and retaining students and on degree completion. In FY 2018, $15.0 million is included for IUSE: Hispanic Serving Institutions (HSI). The primary goals of the IUSE: HSI activity are to promote research on engaged student learning and development of effective STEM learning opportunities at HSIs, especially those that have not had substantial NSF funding, to incentivize institutional and community transformation, and to promote fundamental research about what it takes to diversify and increase participation in STEM effectively, including research that improves the understanding of how to build institutional capacity at HSIs.

- Through the **Advanced Technological Education (ATE)** ($59.0 million, a decrease of $7.04 million) program, NSF is able to reach technicians in undergraduate programs preparing for the high-technology fields that drive our Nation's economy. The ATE program is actively engaged in connecting community college educators funded by the program to the Institutes for Manufacturing Innovation within the National Network for Manufacturing Innovation.

- The **Graduate Research Fellowship Program (GRFP)** ($246.54 million, a decrease of $85.80 million) recognizes students with high potential in STEM research and innovation and provides support for them to pursue multidisciplinary research. GRF fellows may participate in Graduate Research Opportunities Worldwide (GROW), which provides opportunities to conduct research with international partner countries and organizations, and Graduate Research Internship Program (GRIP), which provides professional development through research internships at federal agencies. In FY 2018,

NSF will support 1,000 new fellows, equal to the number supported in FY 2008, a reduction from the 2,000 new fellows NSF has supported annually since 2011.

- **The NSF Research Traineeship (NRT)** ($40.10 million, a decrease of $15.88 million) program invests directly in the development of the STEM workforce, and in the improvement of the education of tomorrow's STEM workforce. NRT funds proposals to test, develop, and implement innovative and effective STEM graduate education models, to promote interdisciplinary and broad professional training of graduate students, and to foster fundamental research advances in support of national priorities. NRT thus provides a mechanism for developing a knowledge base about the implementation and impact of innovative graduate traineeship programs and graduate education policies.

Major Research Equipment and Facilities Construction

In FY 2018, NSF requests funding to continue construction on three projects: the Daniel K. Inouye Solar Telescope (DKIST), Large Synoptic Survey Telescope (LSST), and Regional Class Research Vessels (RCRV).

- The **Daniel K. Inouye Solar Telescope** (DKIST) ($20.0 million) will enable the study of magneto-hydrodynamic phenomena in the solar photosphere, chromosphere, and corona at unprecedented spatial, temporal, and wavelength resolution to gain information on the creation, interaction, and ultimate annihilation of solar magnetic fields. Determining the role of magnetic fields in the outer regions of the Sun is crucial to understanding the solar dynamo, solar variability, and solar activity, including flares and coronal mass ejections. These can affect civil life on Earth through the phenomena generally described as "space weather" and may have impact on the terrestrial climate. FY 2018 is year 10 of an 11-year construction process. In FY 2018, installation of the telescope mount assembly (TMA) will be completed, and commission and acceptance testing of the TMA will be under way. By the end of FY 2018, the installation of the M1 main mirror will be under way and the alignment of the mirror with the laser metrology system will have begun. The first of the five first-light instruments, the visible broadband imager (VBI), will be delivered to the site, assembled, and will begin initial checkout.

- The **Large Synoptic Survey Telescope** (LSST) ($57.80 million) will be an 8-meter-class wide-field optical telescope designed to carry out surveys of the entire sky available from its site. LSST will collect nearly 40 terabytes of multi-color imaging data every night and will produce the deepest, widest-field sky image ever. It will image the entire visible sky twice per week, as well as issue alerts for moving and transient objects within 60 seconds of their discovery. The LSST surveys will result in a comprehensive data set that will enable hundreds of other fundamental astrophysical studies by the entire research community. FY 2018 is year five of a nine year construction process.

- The **Regional Class Research Vessel** (RCRV) ($105.0 million) project will help satisfy the anticipated ocean science requirements for the U.S. East Coast, West Coast, and Gulf of Mexico through the construction of three new research vessels. This project is a major component in the plan for modernizing the U.S. Academic Research Fleet (ARF).[1] RCRVs are important to the national interest in terms of increasing understanding on many subjects including: the potential impacts of geohazards, such as storm surges and tsunamis; transportation and recreational use; natural resource identification and extraction; and fisheries and aquaculture. These vessels will also support the maintenance of coastal observing systems, such as those of the Ocean Observatory Initiative and many other moorings and platforms. This project will help ensure U.S. researchers have access to the sophisticated ships required to meet scientific demands in the coming decades.

[1] National Ocean Council. (2013). *Federal oceanographic fleet status report.*
Retrieved from https://obamawhitehouse.archives.gov/sites/default/files/federal_oceanographic_fleet_status_report.pdf

Organizational Excellence

NSF seeks to integrate mission, vision, and core values to efficiently and effectively execute NSF's activities and provide the flexibility and agility required for all aspects of its operations. This goal incorporates a culture of continuous improvement to ensure effective, inclusive, and accountable programs and merit review processes that provide the greatest value for taxpayer dollars. The portfolio of activities included in Organizational Excellence addresses the agency's operations and administrative functions, which underpin NSF's programmatic activities.

Staffing

In FY 2018, NSF will work towards full utilization of its established allocations of 1,443 FTE for federal staff and 199 FTE for staff hired under the Intergovernmental Personnel Act (IPAs). The Foundation recognizes that maintaining staffing levels is vital to effectively and efficiently achieving its mission.

FY 2018 Priorities

In FY 2018, the primary driver of the decrease for the Agency Operations and Award Management (AOAM) account is the completion of the headquarters relocation to Alexandria, Virginia. Accompanying this is a reduction in the annual rent and utilities for the new headquarters building.

- Underlying the FY 2018 Request is NSF's ongoing commitment to increase agency efficiency while constraining administrative costs.

- This is consistent with the Administration's commitment to manage programs and deliver critical services more effectively, to devote a greater percentage of taxpayer dollars to mission achievement, and to be more effective and efficient in supporting program outcomes—all while improving performance, maintaining staffing levels, and providing for the 1.9 percent cost-of-living adjustment.

- AOAM will continue to support operational activities to ensure the Foundation has sufficient resources to fund ongoing operational requirements and maintain essential services.

2014-2018 Strategic Plan and Performance

2014-2018 Strategic Plan
Integral to this submission is the NSF Strategic Plan for 2014-2018: *Investing in Science, Engineering, and Education for the Nation's Future*. The goals and strategies outlined in the plan build on lessons learned from NSF's past successes and continue to uphold NSF's mission: "To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense...."

The plan presents the following goals, which guide the FY 2018 Budget Request:

- "Transform the Frontiers of Science and Engineering" aims to expand and explore the frontiers of human knowledge to enhance the power of the Nation to meet its challenges, and to create new paradigms and capabilities for scientific, technological, and economic leadership in an increasingly fast-paced, competitive world.

- "Stimulate Innovation and Address Societal Needs through Research and Education" strives to focus NSF's research communities on opening up new avenues to address high priority national challenges, as well as encourages formation of partnerships with industry, other agencies, and international counterparts to leverage resources and build capacity.

- "Excel as a Federal Science Agency" focuses on efficiently and effectively executing the agency's responsibilities and achieving the flexibility and agility required to meet the quickly evolving challenges associated with the first two strategic goals.

This goal structure enables NSF to link its investments to longer-term outcomes. To bridge the gap between these strategic goals and measurable outputs, the Strategic Plan establishes a set of strategic objectives for each strategic goal.

Performance Plan
NSF embraces the use of goals to drive performance improvements. For FY 2018, NSF has set six performance goals so that NSF can strategically monitor and oversee progress being made toward its larger aims. NSF also assesses progress through an annual process of strategic reviews of the objectives in its Strategic Plan.

In FY 2018, NSF will monitor the following annual goals:

- **Ensure that Key Program Investments Are on Track:** Ensure that key FY 2018 NSF-wide program investments are implemented and on track.

- **Ensure that Infrastructure Investments Are on Track:** Ensure program integrity and responsible stewardship of major research facilities and infrastructure.

- **Use Evidence to Guide Management Decisions:** Use evidence-based reviews to guide management investments.

- **Make Timely Award Decisions:** Inform applicants whether their proposals have been declined or recommended for funding in a timely manner.

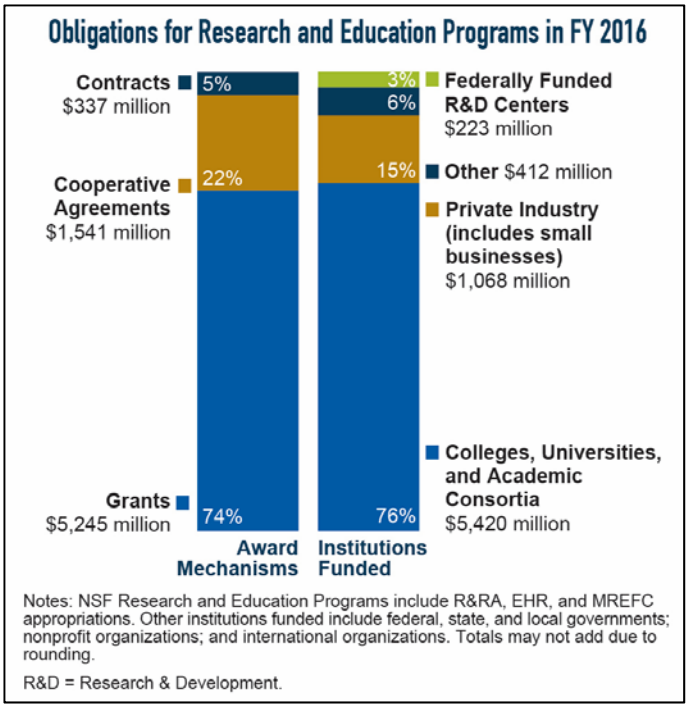
- **Improve Review Quality:** Improve the quality and usefulness to proposers of written reviews of NSF proposals.

- **Foster a Culture of Inclusion:** Foster a culture of inclusion through management efforts resulting in leadership that is committed, knowledgeable, and accountable.

NSF by the Numbers

NSF by the Numbers: In FY 2018, NSF expects to evaluate approximately 50,500 proposals through a competitive merit review process and make approximately 10,800 new competitive awards, which includes 8,000 new research grants. The number of new research grants decreases by roughly 11 percent from previous levels, in keeping with the overall change in total NSF funding. This process typically involves approximately 225,000 proposal reviews, engaging on the order of 34,000 members of the science and engineering community participating as panelists and proposal reviewers. In a given year, NSF awards reach over 1,800 colleges, universities, and other public and private institutions in 50 states, the District of Columbia, and Puerto Rico. In FY 2018, NSF support is expected to reach approximately 292,000 researchers, postdoctoral fellows, trainees, teachers, and students.

The chart on the right shows the distribution of NSF's obligations by institution type and funding mechanism. While the data are based on FY 2016, the relative shares should provide a good indication of the distribution in FY 2018. As shown on the graph, 96 percent of NSF's FY 2016 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.). Contracts are used to acquire products, services, and studies (e.g., program evaluations) required primarily for NSF or other government use.



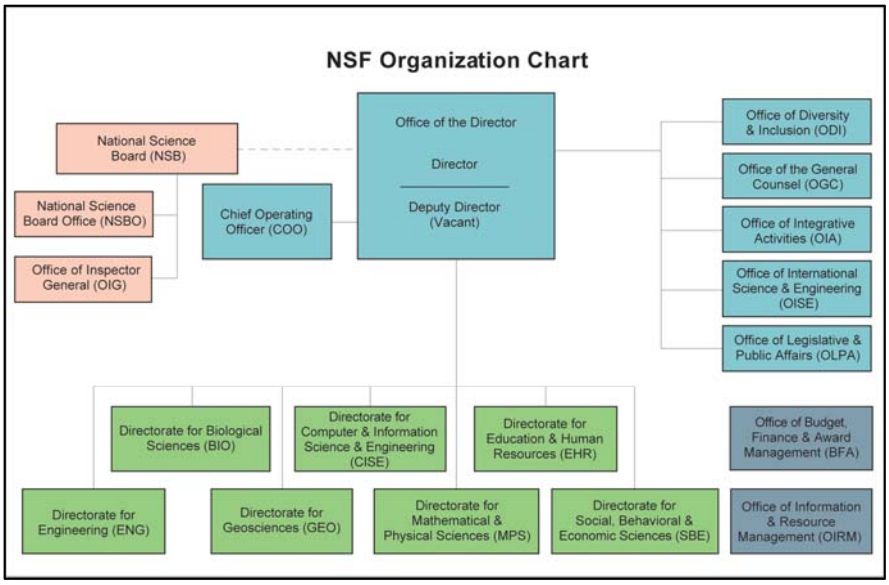
Most NSF awards are to academic institutions. As shown in the chart, 76 percent of support for research and education programs ($5,420 million) was to colleges (including two-year and community colleges), universities, and academic consortia. Private industry, including small businesses, accounted for 15 percent ($1,068 million), and support to federally funded research and development centers (FFRDCs) accounted for 3 percent ($223 million). Other recipients included federal, state, and local governments; nonprofit organizations; and international organizations. A small number of awards fund research in collaboration with other countries, which adds value to the U.S. scientific enterprise and maintains U.S. leadership in the global scientific enterprise.

NSF Research Grant Awards and Funding Rate		
	FY 2016	FY 2018
Research Grant Awards	8,800	8,000
Funding Rate	21%	19%

The funding profile, shown on the left, presents a high-level, agency-wide estimate of funding rates, or proposal "success." This indicator is useful in gauging the relative impact of different funding levels. In FY 2018, the number of new research grant awards is expected to decrease by 800 compared to FY 2016. As noted above, the reduction is in keeping with the overall change in total NSF funding. This leads to a decline in the funding rate.

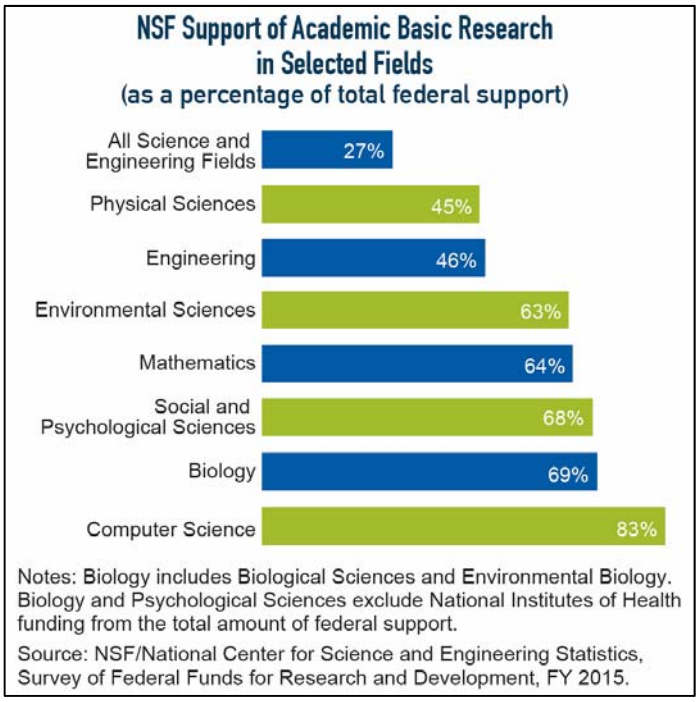
Organization and Role in the Federal Research Enterprise

NSF's comprehensive and flexible support of meritorious projects enables the Foundation to identify and foster both fundamental and transformative discoveries and broader impacts within and among fields of inquiry. NSF has the latitude to support emerging fields, high-risk ideas, interdisciplinary collaborations, and research that pushes—and creates—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, integrative activities, and international science and engineering. The 25-member National Science Board sets the overall policies of the Foundation.

NSF's annual budget represents 27 percent of the total federal budget for basic research conducted at U.S. colleges and universities, and this share increases to approximately 60 percent when medical research supported by the National Institutes of Health is excluded. In many science and engineering fields NSF is the primary source of federal academic support.



Highlights

For nearly 70 years, NSF has invested in fundamental research and education to fulfill its mission of promoting the progress of science and engineering. In doing so, NSF- supported research has connected the discovery and advancement of knowledge with the potential societal, economic, and educational benefits that are critical for continued U.S. prosperity. Below are only some of the important advances that NSF funding enables.

Eteri Svanidze (left) and Emilia Morosan developed a material that could make artificial joints more durable.
Credit: Jeff Fitlow/Rice University

Making Artificial Joints Stronger

Generally, titanium is the material of choice for artificial knees and hips. It is nontoxic, strong, and wears well. However, NSF-funded researchers at Rice University have discovered that adding gold to the metal can make it nearly four times harder than most steels. The new alloy is more compatible with the human body than titanium alone and outperforms it in wear and tear tests. Easy to synthesize, the new material may help reduce the 200,000 surgeries performed each year in the U.S. to replace failed hip and knee implants. This would be an important advance since knee replacements are expected to increase 673 percent and hip replacements by 174 percent by 2030.

Reimagining the Future of Farming

Much of the commercial fertilizer used today goes straight into groundwater. This includes nitrogen, one of fertilizer's main components and an environmental pollutant. NSF-funded researchers are using cutting-edge genomic tools to develop new plant varieties that use nitrogen more efficiently and don't require as much nitrogen to grow. By analyzing the DNA of specific plants, the researchers are working to identify which genes control nitrogen uptake. With approximately 30,000 plant genes to test, this "big data" job uses computers that are able to process large amounts of data quickly. Scientists have identified the gene networks that process nitrogen for use in plant growth and development. Researchers are exploring ways to help farmers get the same crop yield using less nitrogen by modifying the plants' genes. This research holds promise for reducing environmental pollution while also creating greater food security by improving crop yields in parts of the world with nitrogen-poor soil.

Computer science and biology intersect to process plant genomes.
Credit: Nicolle Rager Fuller, National Science Foundation

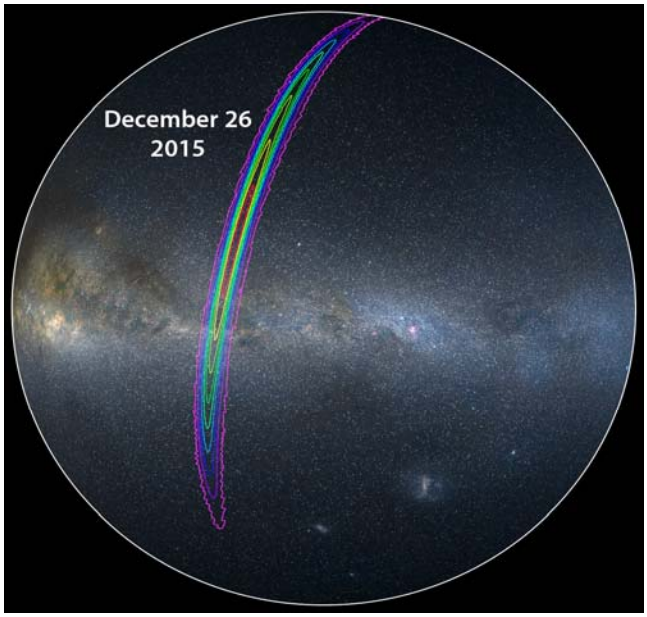
The NSF/NCAR Gulfstream V readies for takeoff on a mission to study a tropical storm. *Credit: Carlye Calvin/UCAR*

High Flyer Targets Hurricanes

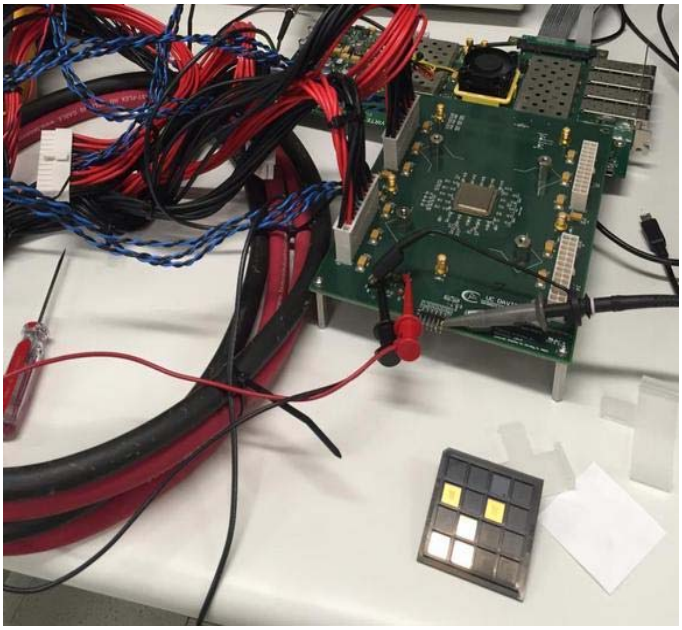
An NSF research aircraft helped improve storm forecasting during the 2016 hurricane season. Flying at altitudes up to 51,000 feet, the plane deploys parachute-borne sensors, known as GPS dropsondes. This NSF-funded technology pinpoints the location of conditions within the storm such as temperature and wind speed. Such observations improve hurricane tracking in the U.S. global weather model by about 15 percent during the 24 to 48 hours before landfall. According to the National Hurricane Center, warnings issued in that window have saved about 200 lives annually. The plane's surveillance missions during hurricane season are a partnership between NSF and the National Oceanic and Atmospheric Administration.

Wave hunting with LIGO

In December 2015, almost three months after the initial confirmation of the existence of gravitational waves in the universe, the NSF-funded Laser Interferometer Gravitational-Wave Observatory (LIGO) captured a second set of waves from another black hole merger 1.4 billion light years away. For the first time, researchers confirmed that one of the black holes was spinning, indicating that the spinning black hole experienced some dynamic process before the merger. Data from this observation allowed researchers to verify the validity of Einstein's theory of relativity, with more precision. NSF was the initial funder of gravitational wave projects 40 years ago and its continued commitment to LIGO's research now enables an entirely new way to observe the universe.



A computer simulates the massive black hole collisions that jettison gravitational waves so strong that NSF's LIGO can detect them billions of light years away. *Credit: LIGO/Axel Mellinger*



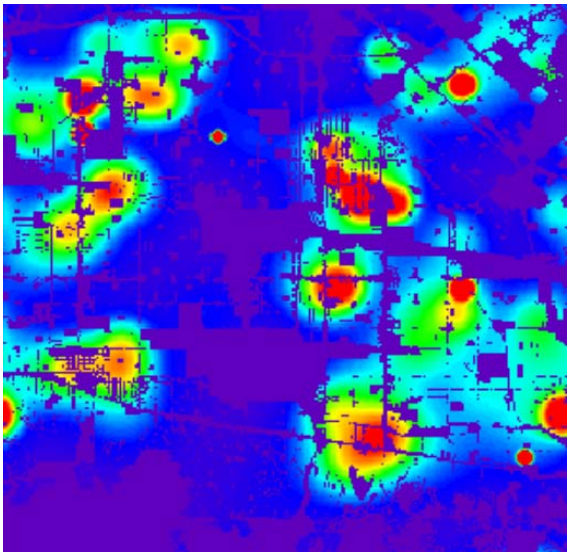
The Kilocore computer chip contains 1,000 independently programmable processors. *Credit: University of California, Davis*

Record-Breaking Computer Chip

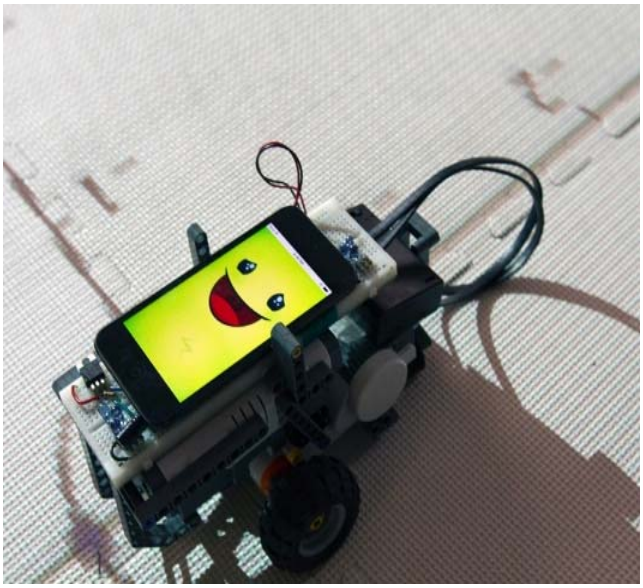
NSF-funded researchers from the University of California, Davis offered a glimpse of the future of data crunching and speedy data delivery in June 2016 when they unveiled their mega-fast 1,000 processor computer chip. The "Kilocore," considered the world's first such chip, has the highest processor rate (115 billion instructions per second) ever designed in an academic setting. As an added bonus, the chip, fabricated by IBM, is highly efficient, requiring only 0.7 watts of power from a single AA battery. That's 100 times more energy efficient than today's laptops. The Kilocore would speed up wireless coding, video processing and other applications involving large amounts of parallel data. Previously, multiple processor chips maxed out at about 300 processors according to the researchers.

Predicting Crime, Preventing Crime

An NSF-funded anthropologist at the University of California, Los Angeles designed a mathematical model to help predict where crime would likely occur. The model incorporated historical crime data, bus routes, business locations, and even weather. It provided police with a series of "prediction boxes," each 500 feet by 500 feet, where they should focus law enforcement efforts. Using the prediction boxes, the Los Angeles police effectively reduced crime in certain patrol areas compared to other patrol areas where standard methods were used. The models predicted twice as much crime as trained analysts using existing skills and technology. Today, more than 50 police departments around the country and world use the predictive policing platform to keep communities safe.



Two-dimensional discrete simulation of burglary hotspots in an 18 x 18 km area of the San Fernando Valley, Los Angeles. *Credit: UC Mathematical and Simulation Modeling of Crime Project*



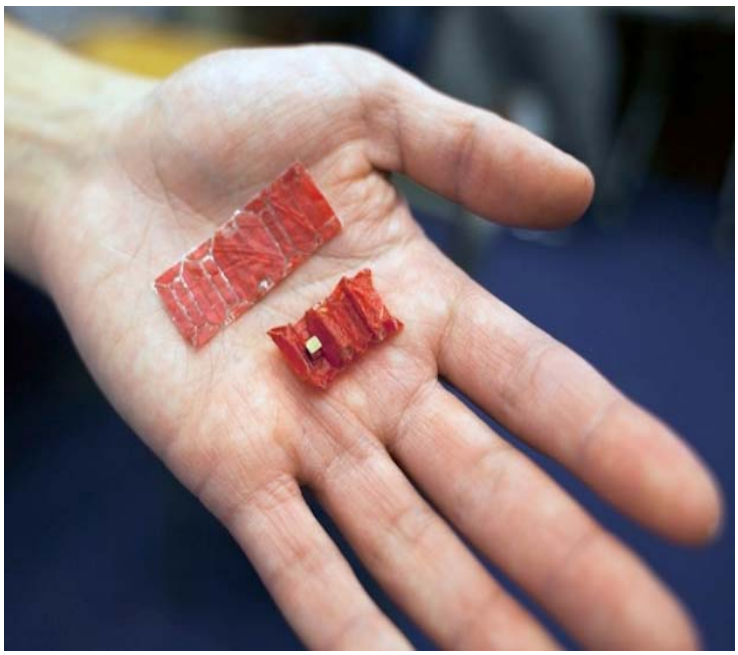
The mighty Quinn rolls across mat, helping students to engage more fully in geometry. *Credit: Pete Zrioka, NYU*

Computer Science Moves Away from the Desk

Computers are now an indispensable tool in the classroom, but for young students the experience can be isolating. To move away from the traditional monitor, keyboard and mouse, a group of NSF-funded researchers, led by researchers at New York University, use a LEGO robot named Quinn to teach basic geometry concepts to middle school students. Quinn is the centerpiece of the Robo-Tangible Activities for Geometry (rTAG) system that encourages physical interactions with a robot. Using an iPod Touch, students "help" Quinn learn how to solve geometry problems as they guide the robot around a large, white floor mat.

Foldable Robots for the Clinic

NSF-funded researchers at the Massachusetts Institute of Technology have developed a tiny foldable robot the size of a small pill. This gives doctors an alternative to surgery to retrieve the some 3,500 button batteries that are swallowed annually in the United States. If left in the body, ingested batteries can burn the digestive tract. Once swallowed, the robot unfolds and moves toward its target via external magnetic field. Then it will dislodge the battery from the stomach lining, allowing both the battery and robot to be naturally passed from the digestive system. Besides foreign object retrieval, the devices can patch wounds and deliver medicine. After completing their mission, the robots are passed through the body or dissolve. The researchers plan to redesign the robot adding sensors so that it can control itself rather than relying on external manipulation.



NSF-funded researchers have developed an origami robot that folds into an ingestible capsule. *Credit: Melanie Gonick, MIT*