Chapter 1

MANAGEMENT'S DISCUSSION AND ANALYSIS

Agency Overview

Mission and Vision

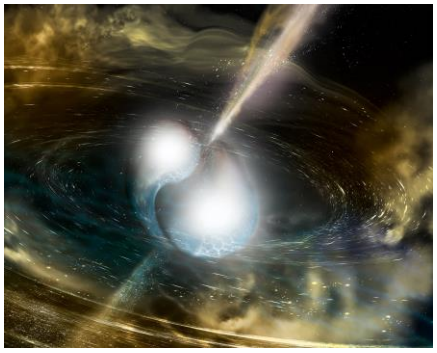
The National Science Foundation (NSF) was established in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…"[1] As the only federal agency responsible for the support of research and education across the full spectrum of science, technology, engineering, and mathematics (STEM) disciplines, this mission continues to guide the agency today. NSF's programs and initiatives play an important role in establishing U.S. leadership in science and engineering fields, foster innovations that drive the economy, strengthen national security, and enhance the well-being of millions of Americans; thereby shaping the nation as a world leader in science and technology.

For over 67 years, NSF has funded discoveries that have been critical to developing new ways of thinking about scientific, economic, and sociotechnical challenges facing the nation and the world. These discoveries have led to innovations such as the Internet, bar codes found on nearly all products, smartphones, magnetic resonance imaging technology, Global Positioning Systems, and improvements in laser microsurgery, such as LASIK eye surgery. NSF supports the basic research that sets the stage for transformative breakthroughs. NSF participation in the multi-agency Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative supports scientists as they investigate new tools that further our understanding of the brain's structure, activity, and function that lay the groundwork for advancing treatments for nervous system disorders or traumatic brain injury. With NSF funding, researchers have developed a bionic eye that allows patients to perceive light, navigate surroundings, and sense movement; their discoveries have led to semiautonomous cars through advances in sensing, real-time data analytics, computer vision, controllers and actuators, and system verification technologies; and at NSF's National Radio Astronomy Observatory, astronomers measured the magnetic field of a galaxy nearly 5 billion light-years away to better understand the formation of galaxies. Other NSF-funded researchers have helped develop more profitable agricultural practices and technologies that have led to higher yield, drought-resistant, and disease-resistant crops that need less water and fertilizer.

LIGO has done it again! For a fourth time, the NSF Laser Interferometer Gravitational-Wave Observatory (LIGO) in Livingston, Louisiana, and Hanford, Washington, has detected gravitational waves—ripples in space-time—from the collision of two neutron stars. The most recent detection, by both LIGO and Virgo (the European detector near Pisa, Italy), was the first observation of gravitational waves by three different detectors and marks a new era of greater insights and improved localization of cosmic events now available through globally networked gravitational-wave observatories.

The three scientists who were seminal in the development of LIGO won the 2017 Nobel Prize in Physics for their work detecting gravitational waves—ripples in space-time created by the motion of massive objects in the universe.

NSF initiated funding for what eventually became the LIGO project 40 years ago; and its continued commitment to LIGO's high-risk, high-reward research has launched a new field of gravitational astronomy that is transforming our understanding of the universe.



Artist's illustration of two merging neutron stars. The narrow beams represent the gamma-ray burst while the rippling space-time grid indicates the isotropic gravitational waves that characterize the merger. Swirling clouds of material ejected from the merging stars are a possible source of the light that was seen at lower energies. *Credit: NSF/LIGO/Sonoma State University/A. Simonnet*.

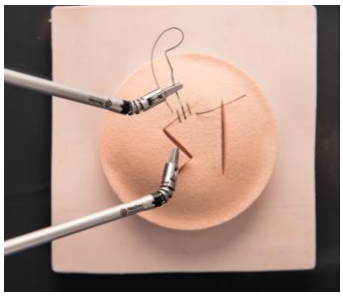
[1] National Science Foundation Act of 1950 (Public Law [P.L.] 81–507).

In fiscal year (FY) 2017, NSF continued investments in research facilities and centers that foster collaboration and provide sophisticated platforms for conducting cutting-edge research. This past year marked the 60-year anniversary of the establishment of NSF's Amundsen-Scott South Pole Station. Among the research projects done at this unique setting, scientists search for clues as to how the universe formed and observe space weather events, which can damage electrical grids, disrupt radio signals, and affect the electronic devices we depend on in our daily lives. Scientists at the NSF-funded Engineering Research Center for Innovative and Strategic Transformation of Alkane Resources (CISTAR) are developing technologies for responsible conversion of light hydrocarbons from shale gas into fuels and chemicals using a network of portable, modular processing plants. Not all investments in scientific endeavors lead to an immediate, clear outcome; but, as we have seen recently, long-term commitment to basic research can lead to remarkable discoveries. During 2017, the Laser Interferometer Gravitational-Wave Observatory (LIGO) continued to detect ripples in space-time, or gravitational waves. LIGO was possible only with decades of NSF support that strategically committed to a high-risk, potentially transformational project. The discovery is opening up new ways to observe and understand our universe. The 2017 Nobel Prize in Physics was awarded to the three scientists who were the architects and leaders of LIGO.

Low-cost mechanical device for minimally invasive surgery. Thanks to researchers and small business entrepreneurs funded by NSF, surgeons can now use a new type of mechanical instrument to perform complex, minimally invasive procedures, also known as laparoscopic surgery.

This handheld instrument provides the same sorts of benefits as robot-assisted surgery, such as greater precision and functionality, but at a lower cost compared to existing robotic surgical systems. The technology even offers a higher degree of dexterity and intuitive control than traditional laparoscopic instruments, which require significant training and can be difficult and tiresome to use—leading to longer surgeries and higher costs.

This innovation could result in less trauma and shorter recovery times after surgery. The simplicity and affordability of this device has great potential in underfunded medical centers in the U.S. and around the world.



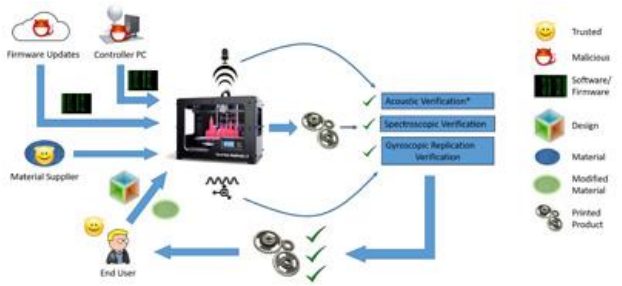
This innovation could provide surgeons with access to a robot-like laparoscopic instrument resulting in less painful recovery. *Credit: FlexDex Surgical*.

NSF's sustained investment in basic research results in a steady pipeline of new ideas and techniques that, together with a highly trained STEM workforce, fosters a world-class research enterprise. For nearly seven decades, NSF has funded the development of STEM talent—from pre-kindergarten through postdoctoral study—preparing and inspiring a culturally diverse and globally competitive workforce of scientists, engineers, and other citizens. Another aspect of this is support for graduate fellowships. For example, NSF has funded over 55,700 Graduate Research Fellows since 1952. Over the years, NSF fellows have made groundbreaking and important discoveries in science and engineering research. Many of them have become leaders in their chosen careers—over 450 have become members of the National Academies of Sciences or Engineering, and 39 fellows have been honored as Nobel laureates. Additionally, NSF has funded the research of 231 people who have gone on to win the Nobel Prize. These investments are an important means by which NSF identifies, nurtures, and invests in scientific potential.

NSF's vision is of a nation that creates and exploits new concepts in science and engineering and provides global leadership in advancing research and education. NSF's core values articulate the essential qualities that staff are encouraged to embody in support of the agency's mission. Among these core values are a dedication to scientific excellence, organizational excellence, learning, inclusiveness, and accountability. NSF strives to excel as a federal agency by investing in priorities that address important national challenges

while promoting economic growth, innovation, and new scientific advancements. NSF's Strategic Plan for 2014–2018, *Investing in Science, Engineering, and Education for the Nation's Future*,[2] identifies three interrelated strategic goals to achieving the agency's mission: (1) transform the frontiers of science and engineering, (2) stimulate innovation and address societal needs through research and education, and (3) excel as a federal science agency. These strategic goals are a roadmap for NSF's success.

Public investment in high-risk, foundational research is key to staying on the cutting-edge of science and technology. Government plays a key role in providing sustained, long-term investments that private industry alone is unable to sustain. NSF supports 27 percent of all federally sponsored basic scientific research conducted by America's colleges and universities; this share increases to 60 percent when medical research supported by the National Institutes of Health is excluded.[3] NSF support of interdisciplinary, high-risk, and potentially transformative research promotes scientific progress and advances scientific frontiers. NSF awards reflect national priorities, keep U.S. researchers and research institutions at the forefront of innovation, and distinguish the United States as a leader in the rapidly changing global landscape of scientific research and discovery. Its research pushes the boundaries of innovation and productivity, sometimes leading to new fields of scientific inquiry and new theoretical paradigms. Increasingly, NSF awards are made where scientific disciplines converge, which reflects the blending of scientific disciplines and engagement of creative partnerships to address complex problems.



Rutgers University-New Brunswick and Georgia Tech engineers have devised three ways to combat cyberattacks on 3-D printers: monitoring printer motion and sounds and using tiny gold nanoparticles. *Credit: Christian Bayens, Georgia Institute of Technology*.

Defeating cyberattacks on 3-D printers. The innovative use of 3-D printers to manufacture objects and parts is increasing in critical fields such as health care, robotics, transportation, aviation, and space. But there is growing concern that cyberattacks on 3-D printers may threaten our health and safety. Instead of spending up to $100,000 or more to buy a 3-D printer, many companies and organizations send software-designed products to outside facilities for printing, where it is possible to hack into a computer's firmware and print defective objects. While the defects are undetectable on the outside, the objects may have holes or fractures inside them.

NSF-funded researchers are developing novel methods to combat future cybersecurity threats to this exciting new technology, staying a step ahead of abuse and sabotage before it can occur.

Today, the economy is stronger, and our knowledge is greater because of NSF-funded basic research. NSF investment in research that enables discovery represents the fulfillment of the Foundation's mission and its commitment to advance the frontiers of science and engineering. This commitment ensures sustained vigor of fundamental research and leverages the nation's innovation ecosystem to maintain global leadership in the 21st century.

[2] NSF's 2014–2018 Strategic Plan: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf14043.
[3] National Center for Science and Engineering Statistics Survey of Federal Funds for Research and Development Fiscal Years 2015–2017. https://ncsesdata.nsf.gov/fedfunds/2015/.

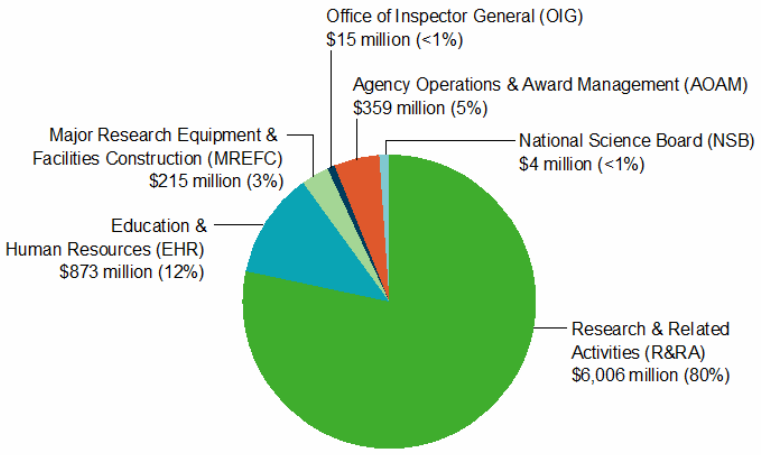
NSF by the Numbers

NSF is funded primarily through congressional appropriations to six accounts: Research and Related Activities (R&RA), Education and Human Resources (EHR), Major Research Equipment and Facilities Construction (MREFC), Agency Operations and Award Management (AOAM), National Science Board (NSB), and Office of Inspector General (OIG). Appropriations in these six accounts in FY 2017 totaled $7,472 million,[4] an increase of $9 million over the FY 2016 appropriations level of $7,463 million. R&RA, EHR, and MREFC appropriations fund the agency's programmatic activities and accounted for 95 percent of NSF's total appropriations in FY 2017. Figure 1.1 provides details on NSF's FY 2017 appropriations.

Figure 1.1

NSF Budget Structure

FY 2017 Appropriations by Account—$7,472 million



Note: MREFC includes $6 million transferred from R&RA to fund NEON construction. AOAM includes $29 million in transfers for NSF headquarters relocation expenses. Transfers to AOAM: $22 million from R&RA, and $7 million from EHR. These transfers were authorized by P.L. 115-31, Consolidated Appropriations Act, 2017.
Totals may not add due to rounding.

- R&RA, which supports basic research and education activities in science and engineering, including high-risk and transformative research, accounted for 80 percent of FY 2017 funding. The FY 2017 R&RA funding level of $6,006 million was $16 million higher than the FY 2016 appropriation of $5,990 million.
- EHR, which supports activities that ensure a diverse, competitive, and globally engaged U.S. STEM workforce and a scientifically literate citizenry is NSF's second largest appropriation, accounting for about 12 percent of the agency's budget. EHR's FY 2017 funding level of $873 million was $6 million, or less than 1 percent, below the FY 2016 EHR appropriation of $879 million.
- The MREFC appropriation supports the construction of unique national research platforms and major research equipment that enable cutting-edge research. This account was 3 percent of the agency's total appropriations in FY 2017. The FY 2017 MREFC funding level of $215 million decreased $3 million, or 1 percent, from the prior-year appropriation of $218 million. The MREFC funding level reflects the transfer of $6 million in R&RA funds to provide additional support for the National Ecological Observatory Network (NEON) construction project.

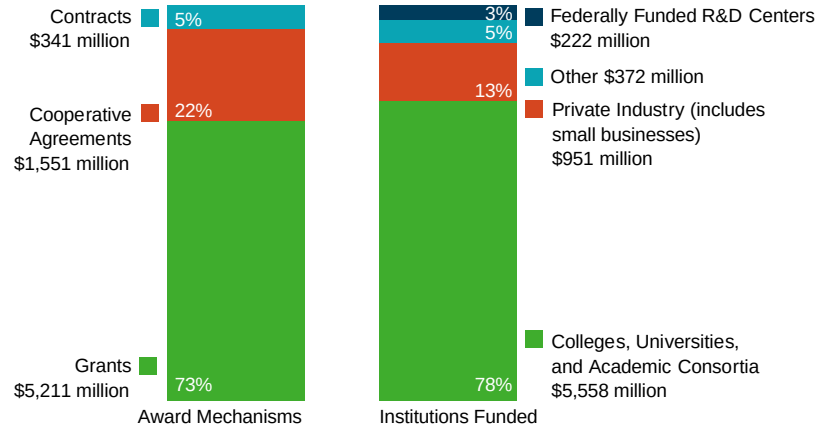
[4] Amount shown is NSF's FY 2017 discretionary appropriations. This amount does not include Donations and H-1B Nonimmigrant Petitioner Receipts. These amounts are included in NSF's appropriations shown in the Statement of Budgetary Resources (SBR). The SBR is on page Financials-17 of this AFR.

- FY 2017 AOAM funding of $359 million supported NSF's administrative and management activities. AOAM was approximately 5 percent of NSF's total FY 2017 appropriations. AOAM increased $2 million, or less than 1 percent, from the FY 2016 level of $357 million. The FY 2017 funding includes $29 million transferred from the R&RA and EHR accounts to support the relocation of NSF's headquarters to Alexandria, Virginia.
- Separate appropriations support the activities of the OIG and the NSB; each accounted for less than 1 percent of NSF's total FY 2017 appropriations. The FY 2017 OIG appropriation of $15.20 million increased $40,000 over the prior-year appropriation of $15.16 million. The NSB received an appropriation of $4.37 million in FY 2017, equal to the previous year's funding level.
- Nearly 34,000 members of the science and engineering community participated in the merit review process as panelists and proposal reviewers.[5] Awards were made to 1,798 institutions in all 50 states, the District of Columbia, and 3 U.S. territories. These institutions employ America's leading scientists, engineers, and educators; and they train the leading innovators of tomorrow. In FY 2017, about 353,000 people were directly involved in NSF programs and activities, receiving salaries, stipends, participant support, and other types of direct involvement. Beyond these figures, NSF programs indirectly impact millions of people, reaching K-12 students and teachers, the general public, and researchers through activities including workshops; informal science activities such as museums, television, videos, and journals; outreach efforts; and dissemination of innovative instructional resources and teaching methods.

Figure 1.2

NSF Award Mechanisms and Institutions Funded

FY 2017 Obligations for Research and Education Programs ($7,103 million)



Notes: NSF Research and Education Programs include—Research & Related Activities, Education & Human Resources, and Major Research Equipment & Facilities Construction appropriations.

Other institutions funded include federal, state, and local governments; nonprofit organizations; and international organizations.

R&D = Research and Development.

Totals may not add due to rounding.

During FY 2017, NSF evaluated over 49,400 proposals through a competitive merit review process and made over 11,450 new competitive awards, mostly to academic institutions. In addition to these proposals, GRFP reviews approximately 12,500 applications for fellowships annually. As shown in Figure 1.2, 78 percent of support for research and education programs ($5,558 million) was to colleges, universities, and academic consortia. Private industry, including small businesses, accounted for 13 percent ($951 million), and support to Federally Funded Research and Development Centers accounted for 3 percent ($222 million). Other recipients ($372 million) included federal, state, and local governments; nonprofit organizations; and international organizations. A small number of awards fund international

[5] For more information about NSF's merit review process, see https://www.nsf.gov/bfa/dias/policy/merit_review/ and *Report to the National Science Board on the National Science Foundation's Merit Review Process, FY 2016* (NSB-2017-26) at https://www.nsf.gov/nsb/publications/2017/nsb201726.pdf.

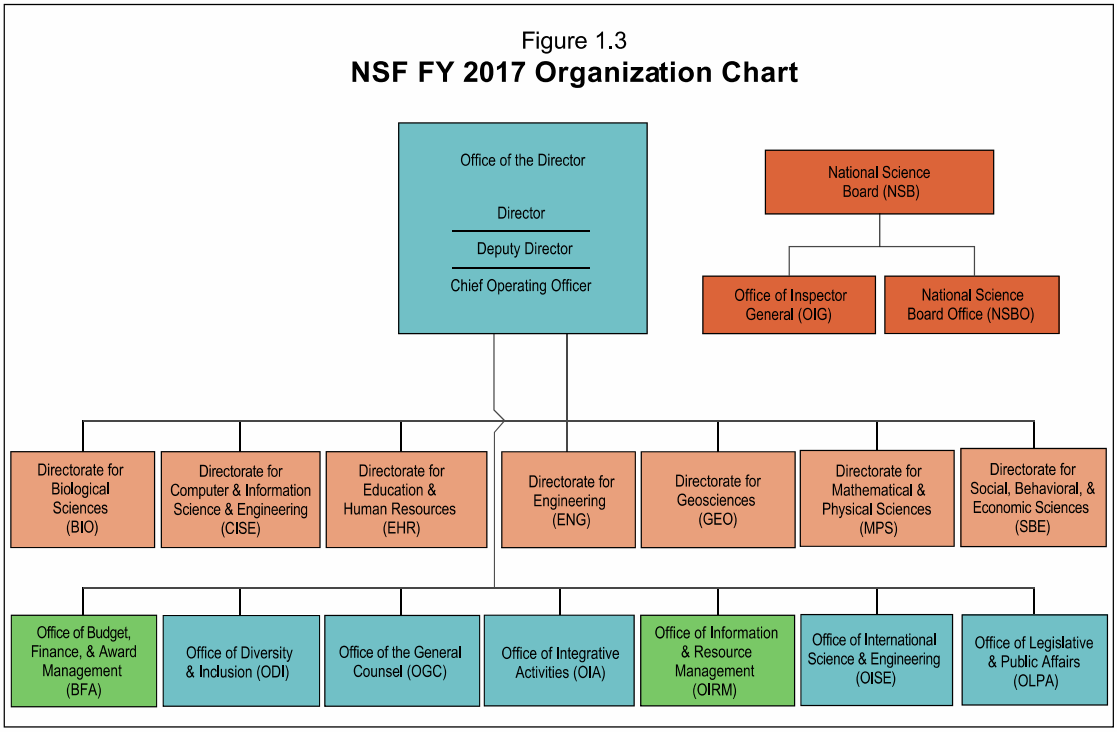
science and engineering research, education, and partnerships, which add value to the U.S. scientific enterprise and maintain U.S. leadership in the global scientific enterprise.

As shown in Figure 1.2, NSF's award funding was primarily for financial assistance through the use of grants and 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 multiyear 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-use facilities). Contracts (procurement instruments) are used to acquire products, services, and studies (e.g., program evaluations) required for NSF or other government use.

Organizational Structure

Figure 1.3 shows the organization chart for NSF. NSF is an independent federal agency headed by a Director who is appointed by the President and confirmed by the U.S. Senate.[6]

Figure 1.3
NSF FY 2017 Organization Chart



The NSF Director and the 24-member NSB jointly pursue the goals and function of NSF, including the duty to "recommend and encourage the pursuit of national policies for the promotion of research and education in science and engineering."[7] The NSB identifies issues critical to NSF's future and helps chart the strategic direction of NSF's budget and programs. The Board also serves as an independent body of advisors to both the President and the Congress on policy matters related to STEM research and education. NSB members are appointed by the President and are prominent contributors to the STEM research and

[6] The Director's biography is available at https://www.nsf.gov/news/speeches/cordova/cordova_bio.jsp/
[7] 42 U.S. Code 1862(d): https://www.law.cornell.edu/uscode/text/42/1862.

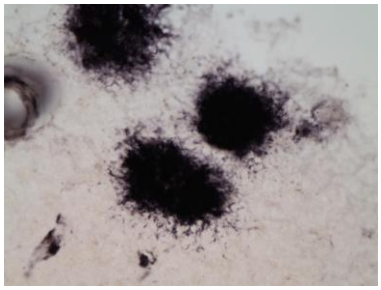
education community.[8] NSF's Director is a member *ex officio* of the Board. The Director and the other NSB members serve 6-year terms.

The NSF workforce includes 1,430 federal employees.[9] NSF also regularly recruits scientists, engineers, and educators through the Intergovernmental Personnel Act (IPA) who work at NSF for up to 4 years.[10] These "rotators" bring fresh perspectives from across the country and across all fields of science supported by the Foundation, helping explore new directions for research in science, engineering, and education, including emerging interdisciplinary fields. On returning to their home institutions and across academia, rotators bring knowledge of NSF programming and leading research from a national perspective. As shown in Figure 1.3, NSF's organizational structure aligns with the major fields of science and engineering.[11]

Near the end of FY 2017, the agency's headquarters relocated to Alexandria, Virginia. NSF maintains offices in Brussels, Belgium; Tokyo, Japan; and Beijing, China, to facilitate its international activities and an office in Christchurch, New Zealand, to support the U.S. Antarctic Program (USAP).

New research detects Alzheimer's disease markers in nonhuman primates. Proteins associated with Alzheimer's disease—believed to be unique to humans—have been discovered in a sample of brains of aged chimpanzees. It has been suggested that humans are uniquely susceptible to Alzheimer's, potentially because of genetic differences from other primates, changes to the human brain during evolution, and longer lifespans.

Understanding these differences can provide key insights into identifying the causes of Alzheimer's and working toward a cure. The identification in the aged chimpanzees of amyloid beta and tau lesions, hallmarks of Alzheimer's diagnosis, is a significant advance in understanding the brain and Alzheimer's.



Amyloid beta plaques in the brain of a 58-year-old female chimpanzee. *Credit: Mary Ann Raghanti, Kent State University*.

Management Challenges

In October 2016, the OIG identified seven major management and performance challenges for the agency for FY 2017: (1) establishing accountability over large cooperative agreements, (2) management of NSF's business operations, (3) management of the IPA program, (4) moving NSF headquarters to a new building, (5) management of USAP, (6) improving grant administration, and (7) encouraging the ethical conduct of research.[12]

Management's report on the significant activities undertaken in FY 2017 to address the challenges is located in *Appendix 4B: Management Challenges —NSF's Response* of this AFR. The report also discusses activities planned for FY 2017 and beyond. Some of the agency's significant actions and planned next steps to address the challenges are highlighted below.

[8] A list of NSB members is available at https://www.nsf.gov/nsb/members/.
[9] Full-time equivalents (FTE) include the federal employee workforce for NSF, NSB, OIG, and U.S. Arctic Research Commission.
[10] As of September 30, 2017, temporary appointments included 174 under the IPA Mobility Program.
[11] NSF's organization chart is available at: https://www.nsf.gov/staff/organizational_chart.pdf.
[12] The Inspector General's memorandum on Management Challenges for NSF in FY 2017 is in NSF's *FY 2016 Agency Financial Report* Appendix 5A at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf17002.

Establishing Accountability over Large Cooperative Agreements

NSF has been continuously enhancing its pre- and post-award oversight of major facilities in construction and operations since June 2014. These enhancements are documented in the latest revision of the Large Facilities Manual (LFM)[13] and internal agency guidance. Building on these improvements, NSF focused, in FY 2017, on implementation of the recommendations set forth in the December 2015 report by the National Academy of Public Administration (NAPA).[14] The NAPA report supported NSF's use of cooperative agreements, while also noting that NSF should "*apply equal emphasis to increased internal management of the business practices critical to the enhanced oversight and project success*" in order to bring them into balance with the science and technical aspects of oversight. Examples of actions taken by NSF in FY 2017 include revising the LFM (NSF 17-066) to align with the American Innovation and Competitiveness Act[15] requirements and other newly strengthened agency oversight requirements, naming the NSF Chief Operating Officer (COO) as the agency Senior Accountable Official for major facilities oversight, and implementing a process for conducting incurred cost audits and accounting system audits. To ensure that the agency has access to reliable Earned Value Management (EVM) data, NSF implemented formal procedures for EVM System (EVMS) verification, acceptance, and surveillance. NSF completed EVMS acceptance on the Daniel K. Inouye Solar Telescope and Large Synoptic Survey Telescope projects and completed verification review of the Regional Class Research Vessel project. Overall, NSF focused on ensuring that effective implementation of its new policies led to enhanced oversight of its major facilities while balancing administrative burden for NSF and its recipients. In FY 2017, NSF leveraged the expertise of its Advisory Committee on Business and Operations (BOAC) by (1) receiving and implementing a subcommittee's recommendations relating to the NAPA report, and (2) initiating a second subcommittee on cost surveillance to independently assess NSF's strengthened policies and procedures. To date, the agency has taken action to close nearly 62 of 65 (95 percent) of the OIG recommendations related to oversight of major facilities dating back to 2012.

Going forward, NSF plans to continue strengthening its oversight by (1) finalizing guidance around an annual major facilities portfolio risk assessment, (2) strengthening the role and composition of the MREFC Panel to include life-cycle oversight of facilities, (3) adopting and implementing new guidance in areas such as management reserve and Internal Management Plans, and (4) formalizing a lessons-learned program and NSF Communities of Practice.

Management of NSF's Business Operations

- *Improper payments*—In May 2017, the NSF OIG issued a report on NSF's compliance with the improper payment requirements for FY 2016. The OIG concluded NSF complied with the requirements and had addressed all recommendations from the previous OIG report. This was the second consecutive report finding NSF in compliance with improper payment reporting requirements. The May 2017 OIG report had no recommendations and no resolution tracking requirements. The consecutive reports validate that NSF has taken the steps necessary to demonstrate compliance and effectiveness in the agency's implementation of improper payment requirements; thus NSF management does not consider improper payments to be a significant risk to NSF's mission, programs, or operations. NSF will conduct an improper payment risk assessment in FY 2018.
- *Information & IT resources*—NSF continued to operate a strong program employing effective tools and technology to continuously monitor its network availability and security posture, incorporating information gained and lessons learned from the agency's Federal Information Security Management

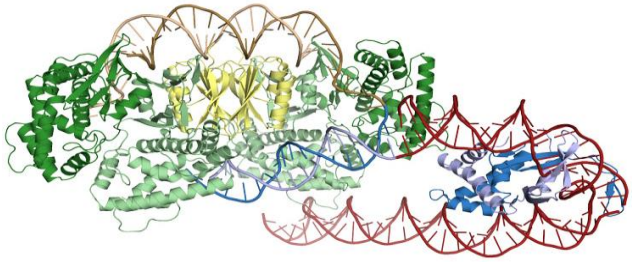
[13] Large Facilities Manual: https://www.nsf.gov/pubs/2017/nsf17066/nsf17066.pdf.
[14] *National Science Foundation: Use of Cooperative Agreements to Support Large Scale Investment in Research* https://www.napawash.org/academy-studies/search/eyJyZXN1bHRfcGFnZSI6ImFjYWRlbXktc3R1ZGllc1wvc2VhcmNoIiwieWVhciI6IjIwMTUifQ
[15] American Innovation and Competitiveness Act (P.L. 114–329): https://www.congress.gov/bill/114th-congress/senate-bill/3084/text.

Act of 2002 (FISMA) report. NSF ensured effective operations during the physical relocation of agency headquarters to a new building. The Foundation also completed a thorough review of USAP information technology (IT) security program controls, allocating appropriate resources to address FISMA findings.

- *DATA Act implementation*—NSF successfully certified and submitted the Digital Accountability and Transparency Act (DATA Act) files on April 28, 2017, and agency data were included in the U.S. Department of Treasury's May 2017 rollout of the beta version of USASpending.gov. NSF received the Secretary's Certificate of Appreciation from Treasury for outstanding commitment to collaboration. NSF will continue to collaborate agency-wide, government-wide, and with the OIG and audit community toward continued success in achieving the goals of the DATA Act.
- *Government records*—In November 2015, NSF submitted a corrective action plan to address a Government Accountability Office (GAO) report finding that agencies needed to take action to meet the requirements of the National Archives and Records Administration (NARA) directive related to reforming the policies and practices for the management of physical records and providing a framework for the management of electronic records. In FY 2017, NSF designed and executed a plan to manage its permanent records, including scanning over 7,000 permanent and temporary records to reduce the footprint of hardcopy files ahead of NSF's move to its new headquarters. Going forward, NSF will update its records management policy to comply with current NARA guidance and federal regulations while also preserving critical agency documentation for use by the Office of the General Counsel, OIG, and the scientific community.

Management of the IPA Program

Through the IPA program, scientists, engineers, and educators rotate into the Foundation as temporary Program Directors, advisors, and leaders. They bring fresh perspectives that help explore new directions for research in science, engineering, and education, including emerging interdisciplinary fields. NSF's IPA Steering Committee was established in April 2016 to oversee the ongoing implementation of the program and champion the effective use of IPAs. In FY 2017, NSF took several actions to improve the effectiveness of the program, protect against conflict of interest, and reduce cost. For example, in March 2017, the agency issued a memorandum reminding IPAs and all staff of their ethical responsibilities. Also in FY 2017, NSF initiated a pilot requiring cost sharing by the IPA's home institution, published guidance limiting NSF payment of IPA independent research and development travel, and implemented a process for the NSF COO's review of IPA salary cases that exceed the Senior Executive Service cap. In June 2017, the NSF OIG issued an audit report concluding that NSF had "implemented internal controls to identify and mitigate IPA conflicts of interest." NSF will continue to strengthen the program through the implementation of additional controls and continued assessment of the pilot efforts.



A protein called IHF (blue) creates a sharp turn in the DNA (red helix) upstream of the CRISPR repeat (brown helix), allowing Cas1-Cas2 (green and yellow) to recognize and bind the insertion site. *Credit: Addison Wright image*.

New technique enables safer gene-editing therapy using CRISPR. NSF-funded researchers studying how a bacterium's immune system fights off viruses uncovered a powerful new gene-editing technique called CRISPR-Cas9. CRISPR-Cas9 acts like a pair of molecular-sized scissors that researchers can wield to snip a segment of DNA; for example, to edit a segment that codes for a particular trait in an organism.

Biomedical researchers are exploring CRISPR-Cas9's potential use for everything from treating genetic disorders and developing targeted cancer therapies to preventing vector-borne infectious diseases. The agricultural industry is also exploring whether CRISPR-Cas9 can help enhance crop production and livestock survival.

New findings were published on July 20, 2017, in *Science* that explain how proteins, responsible for the CRISPR immune system's ability to adapt to new viral infections, identify the site in the genome where they insert viral DNA so they can recognize it later and mount an attack.

Moving NSF Headquarters to a New Building

NSF began occupying its new location in Alexandria, Virginia, in August 2017. In FY 2017, the relocation was routinely monitored by NSF leadership, and the NSF Relocation Office (NRO) led a multi-faceted outreach effort to prepare staff for the relocation. The move was successful—the construction and physical relocation were completed on time, and NSF procurements were under budget. By December 31, 2017, NSF will decommission its Arlington locations and will complete its relocation to Alexandria.

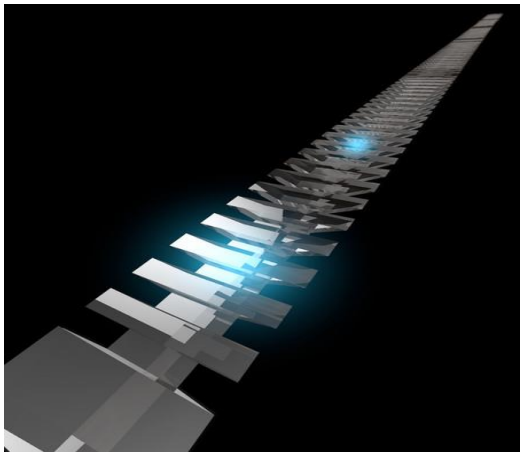
Management of the U.S. Antarctic Program

NSF focused on ensuring a successful transition, from Lockheed Martin to Leidos as the Antarctic Support Contractor (ASC), by strengthening the agency's understanding of the strategic rationale for the transition and by monitoring Leidos' operations on legacy Lockheed Martin systems, including the Accounting System, Estimating System, Material Management and Accounting System, Purchasing System, and Property System. Also in FY 2017, NSF continued progress on implementing the 2012 Blue Ribbon Panel recommendations, including investing in lifecycle acquisitions and infrastructure upgrades for McMurdo Station through continued design efforts.[16] Other significant agency actions included (1) improving USAP participant guidance for Physical Qualification (PQ) exams, clarifying expectations relating to required tests and nonreimbursable costs; (2) continuing to apply invoice processing; and (3) requesting periodic, full listings of materials/items of less than $5,000 for review. NSF will continue to monitor the ongoing transfer of business systems from Lockheed Martin to Leidos, initiate and complete necessary solicitation efforts for individual Antarctic Infrastructure Modernization for Science (AIMS) project components, and continue to review and modify PQ requirements, including during the annual medical review panel meetings.

First on-chip nanoscale optical quantum memory developed. With NSF funding, researchers have built the first nanoscale optical quantum memory device that could one day be used to create more reliable and secure internet communications.

Quantum memory stores information in a similar fashion to the way traditional computer memory does, but on individual quantum particles—in this case, photons of light. This allows it to take advantage of the peculiar features of quantum mechanics to store data more efficiently and securely.

The use of individual photons to store and transmit data has long been a goal of engineers and physicists because of photons' potential to carry information reliably and securely. Because photons lack charge and mass, they can be transmitted across a fiber optic network with minimal interactions with other particles.



Artist's representation of Faraon's quantum memory device. *Credit: Ella Maru Studio.*

Improving Grant Administration

In FY 2017, major accomplishments in strengthening grant administration included (1) implementation of the restructuring of NSF's Cost Analysis and Audit Resolution Branch into two separate units focused on pre- and post-award functions to better address continuing growth in complexity and breadth of oversight functions; (2) continuation of a multi-year effort to modernize NSF's Award System, which included implementation of functionality that enables program staff to seamlessly manage $860 million in funding increments to over 4,600 awards; and (3) successfully piloting a new tool, the Targeted Review Assessment (TRA), that allows NSF to quickly assess areas of grants management and compliance and to provide targeted, necessary business assistance to the awardee community. In the coming year, NSF will continue

[16] *U.S. Antarctic Program Blue Ribbon Panel Report*: https://www.nsf.gov/geo/plr/usap_special_review/usap_brp/rpt/index.jsp.

to strengthen grant administration through such efforts as initiating a fraud risk assessment within the grants program, refining its enterprise risk management (ERM) risk profile, continuing to implement legislative requirements under the DATA Act and the Grants Oversight and New Efficiency (GONE) Act, and working to strengthen prime awardees' compliance with the Office of Management and Budget (OMB) *Uniform Guidance* through enhanced implementation of internal controls over their subawardees.

Encouraging the Ethical Conduct of Research

NSF recognizes that the responsible and ethical conduct of research is critical to ensure excellence, as well as public trust, in science and engineering. NSF requires each institution that submits a proposal to certify it has a plan to provide appropriate training and oversight in the ethical conduct of research to all undergraduates, graduate students, and postdoctoral researchers involved in NSF-supported research. In August 2017, NSF published Important Notice No. 140[17] to Presidents of Universities and Colleges and Heads of Other National Science Foundation Grantee Organizations addressing Training in Responsible Conduct of Research. Also in August 2017, the NSB discussed both the OIG report, "Review of Institutions' Implementation of NSF's Responsible Conduct of Research Requirements," and the National Academies of Sciences, Engineering, and Medicine (NASEM) report, "Fostering Integrity in Research." The OIG report made several important observations about the ethical conduct of research that NSF is incorporating into its approach. As in previous years, in FY 2017, NSF's Cultivating Cultures for Ethical STEM (CCE STEM) program invested in innovative approaches to foster ethical STEM research in all of the fields of science and engineering that NSF supports. Federal funding of research on the ethical conditions in the research environment was a key recommendation in the NASEM report. The Foundation also continued funding of the Online Ethics Center website and funded two key ethics workshops in March 2017: "Qualitative Research Ethics in the Big-Data Era" and "Positive Research Integrity." NSF will continue to fund CCE STEM research projects that use basic research to identify what nurtures, hinders, or challenges responsible or irresponsible conduct of science, how just or unjust scientific practices become embedded in sociotechnical systems, and how to best instill this knowledge in students. In addition, NSF continues interactions with the scientific community to monitor and adapt practice in this area, most recently by participating in review and discussion of the "Fostering Integrity in Research" report.

[17] Important Notice No. 140: Training in Responsible Conduct of Research: https://www.nsf.gov/pubs/issuances/in140.jsp.

Proposal Workload and Management Trends

NSF continuously monitors key portfolio, proposal workload, and financial measures to understand short- and long-term trends and to help inform management decisions. For an analysis of the long-term trends in competitive proposals, awards, funding rate, and other portfolio metrics, see the *Report to the National Science Board on the National Science Foundation's Merit Review Process, Fiscal Year 2016.*[18]

Overall, the FY 2017 portfolio indicators of competitive proposals acted upon, new awards, and funding rates are relatively stable between FY 2016 and FY 2017, as shown in Figure 1.4.

Figure 1.4

Number of NSF Competitive Proposals, New Awards, and Funding Rates

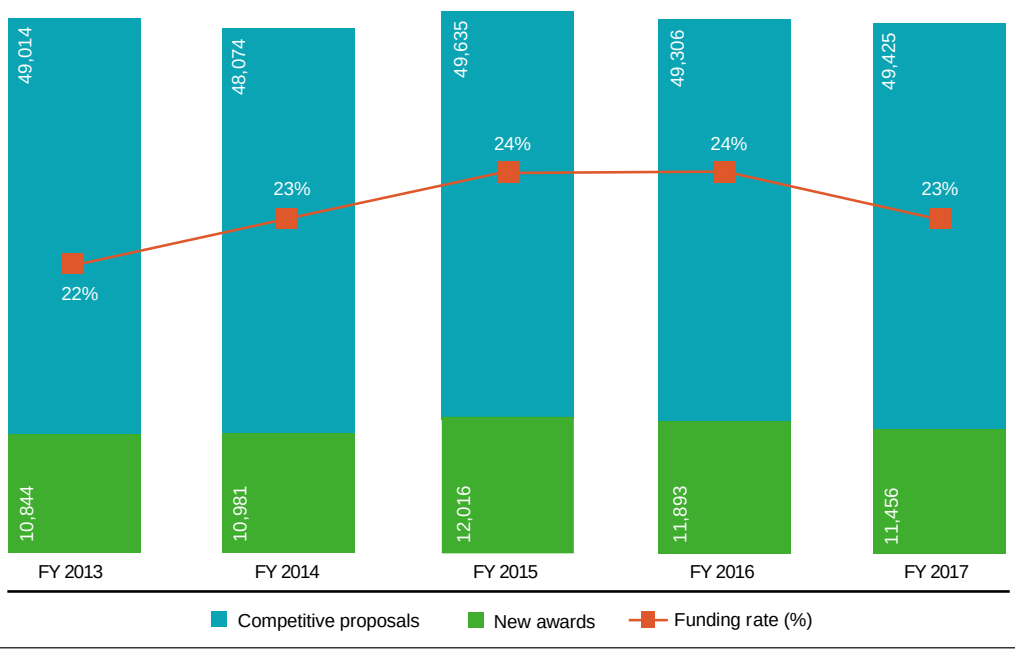


Table 1.1 provides 5 years of data on NSF's portfolio, proposal workload, and financial indicators. In summary:

- Between FY 2016 and FY 2017, the number of competitive proposal actions was stable and in excess of 49,000.
- The number of new awards in FY 2017 was close to 11,500, a small decrease from FY 2016, and almost exactly the average amount of new awards for the 5 years FY 2013–2017.
- The overall funding rate in FY 2017 was 23 percent, a decrease of 1 percentage point. Funding rates differ by directorate and are presented in the agency's annual budget request to Congress.
- The average annual award size of competitive awards was $174,533, slightly lower than in FY 2016. As shown in Table 1.1, award size varies by year. The FY 2017 average annual award size is higher than the 5-year average, $172,983.
- There was a 2-percent increase in the number of employees (full-time equivalents, or FTE) between FY 2016 and FY 2017, from 1,398 FTE to 1,430 FTE.

[18] *Report to the National Science Board on the National Science Foundation's Merit Review Process, Fiscal Year 2016* (NSB-2016-41) at https://www.nsf.gov/publications/ods/results.jsp?TextQuery=nsb201726.

- The number of active awards increased slightly in FY 2017, from 54,439 in FY 2016 to 54,806 in FY 2017. The 5-year average of active awards is 54,460.

All NSF awardee institutions are required to submit payment requests at the award level to the NSF Award Cash Management Service (ACM$). Award expenses are posted to the NSF financial system at the time of the payment request. To further expand payment activity in ACM$, starting in January 2017, all postdoctoral research fellowship awardees began to utilize ACM$ for their monthly stipend payments. At year-end close, nearly 500 postdoctoral research fellows have accessed ACM$. Reliance on ACM$ reduces the burden of manual invoicing and potential for errors or missed payments.

Table 1.1 – Proposal Workload and Management Trends

Measure		FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	Percent Change (FY 2017 FY 2016)	Average (FY 2013 FY 2017)
Portfolio	Competitive proposal actions	49,014	48,074	49,635	49,306	49,425	0.2%	49,091
	Competitive award actions	10,844	10,981	12,016	11,893	11,456	– 3.7%	11,438
	Average annual award size (competitive awards)	$169,107	$180,507	$164,526	$176,243	$174,533	– 1.0%	$172,983
	Funding rate	22%	23%	24%	24%	23%	– 1 percentage point	23%
Proposal Workload	Number of employees FTE, usage[1]	1,417	1,391	1,374	1,398	1,430	2.3%	1,402
	Number of active awards[2]	55,542	53,546	53,967	54,439	54,806	0.7%	54,460
	Proposal reviews conducted[3]	233,116	225,847	231,450	225,017	203,438	– 9.6%	223,774
Financial	Number of grant payments	27,649	27,978	22,860	22,926	22,615	– 1.4%	24,806
	Award expenses incurred but not reported at 9/30 ($ in millions)[4]	$344	$250	$369	$366	$381	4.1%	$342

Notes:
[1] Full-time equivalents (FTE) include the federal employee workforce for NSF, NSB, OIG, and U.S. Arctic Research Commission.
[2] Active awards include all active awards regardless of whether funds were received during the fiscal year.
[3] Includes written reviews, panel summaries, and site visit reports.
[4] FY 2017 number reflects an accrual, and all other years reflect actuals.

Since its introduction in FY 2013, ACM$ has significantly improved the timeliness of grant financial data. In prior years, NSF awardee institutions using quarterly expense reporting processes had approximately $1.7 billion in award expenses that they had incurred but not-yet-reported to NSF on September 30. With the use of AMC$ and its expansion each year to include additional award groups, the amount of incurred but not-yet-reported award expenses has decreased to under $400 million for each of the last 5 years.

Progress toward Achievement of Performance Goals

Each year, NSF produces an *Agency Financial Report* and an *Annual Performance Report (APR)*. NSF's *FY 2017 APR* will provide a complete discussion of the Foundation's performance measures, including descriptions of the metrics, methodologies, results, and trends, along with a list of relevant external reviews. The *FY 2017 APR* also will provide information about NSF's verification and validation review of performance data, as required by the Government Performance and Results Modernization Act of 2010. NSF's *FY 2017 APR* (included in the *FY 2019 Budget Request to Congress)* and *FY 2017 Performance and Financial Highlights* summary report will be posted on the NSF website on February 5, 2018.[19]

Native students graduating with advanced science degrees. Northwest Indian College in Washington State offers one of the few Bachelor of Science in Native environmental science programs in the world.

Supported by NSF's Tribal Colleges and Universities Program (TCUP), the first student enrolled in the program graduated in 2009. Since then, 51 students have graduated from the program, with 10 more on track to graduate in 2017 and another 81 currently enrolled.

Of the 2016 graduates, 6 are pursuing advanced degrees, and the first Ph.D. graduate will return to the college as a faculty member.

TCUP makes awards to Tribal, Alaska Native-, and Native Hawaiian-serving institutions. *Credit: Marco Hatch, Western Washington University.*

[19] *FY 2017 Agency Performance Report* (included in the Performance chapter of the FY 2019 Budget Request to Congress) and *FY 2017 Performance and Financial Highlights*: https://www.nsf.gov/about/performance/.

Financial Discussion and Analysis

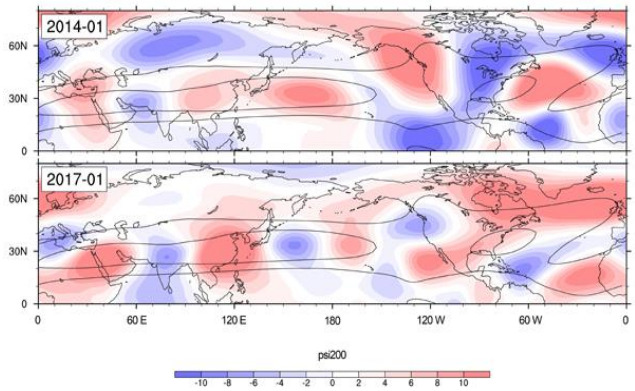
NSF's directorates and offices work together to uphold the agency's strong commitment to excellence in financial responsibilities, improved business processes, increased data transparency, responsible stewardship of federal funds, and accountability. In FY 2017, business operations highlights included:

- *Digital Accountability and Transparency Act of 2014 (DATA Act)*—NSF successfully implemented the requirements of the DATA Act, ushering in a new era of access to government-wide award and financial data. Staff expertly leveraged the capabilities of NSF's new financial system with the longstanding integration of its grant and financial systems to meet DATA Act requirements. Agency staff engaged in a 2-year coordinated collaboration and implementation effort, led by the U.S. Department of Treasury and OMB, that resulted in NSF receiving the only award given by the Secretary of the Treasury to a federal agency in recognition of this type of excellence.
- *Grants Oversight and New Efficiency (GONE) Act Reporting*—In FY 2017, NSF conducted a full analysis of expired awards meeting the reporting requirements of the Act and made significant progress in administratively closing awards and compiling data for the report. Having already financially closed these awards and repurposed the funds, none of these administrative closures carried financial balances. The results of NSF's review can be found in *Appendix 4, Grants Oversight and New Efficiency (GONE) Act Requirements*, of this AFR.
- *Enterprise Risk Management*—To better manage risks toward achieving strategic objectives, while leveraging NSF's existing resources and capabilities, the Foundation made significant progress in implementing its ERM framework. In FY 2017, NSF prepared an initial risk profile for the agency in accordance with Circular A-123, *Management's Responsibility for Enterprise Risk Management and Internal Control*. NSF fully supports the concept that when risks are understood and managed properly, the agency operates more efficiently and effectively, is able to prioritize and allocate resources more strategically, and becomes more resilient and better able to manage change. Going forward, NSF will continue to expand its discussions about risk across the agency with the goal of fully integrating ERM into its strategic planning, budget formulation, performance assessment, and quality control improvements.
- *Targeted Review Assessment*—For over a decade, NSF's annual risk assessment has been used to identify awardees for advanced monitoring. In FY 2017, NSF leveraged that program by piloting a new tool, the TRA, intended to quickly assess grants management and compliance and to identify the awardee community's need for business assistance. The first TRA, focused on subrecipient oversight, found that the majority of sampled pass-through institutions had appropriate policies and procedures or needed only minor updates. Relatively few needed to develop internal controls for addressing closeout, subrecipient risk assessments, and/or the review of subrecipients' single audit reports. NSF shared results of its analysis with the NSF OIG that is auditing NSF's oversight of pass-through entities' subrecipient monitoring, pursuant to the *American Innovation and Competitiveness Act.*
- *Indirect Cost Rates*—In September 2017, GAO issued *National Science Foundation: Actions Needed to Improve Oversight of Indirect Costs for Research (GAO-17-721),* which is a review of the amount of NSF funding for indirect costs and NSF's negotiation of indirect cost rates (ICRs). Indirect costs afforded to research institutions represent a share of true costs attributable to the conduct of doing research. Between 2000 and 2016, indirect costs varied from 16 to 24 percent of total annual award amounts, based on types of activities supported and types of awardee organizations. GAO recommended that NSF improve its internal guidance for setting ICRs, including adding certain details and procedures. NSF is addressing GAO recommendations.
- *Invoice Processing Platform (IPP)*—NSF continued to demonstrate its focus on efficient financial operations that support the agency's mission by going live with the Department of Treasury's web-

based e-Invoicing system, or IPP, on July 31, 2017—a year ahead of OMB's deadline. IPP promotes NSF's digital documentation efforts, supports efficient invoice processing, and results in cost savings to NSF and the vendors by moving to a paperless invoicing and payment system. Approximately 485 NSF vendors (excludes grantees, IPAs, panelists, employees, or other federal entities) are registered to submit invoices electronically through IPP. NSF expects to receive approximately 3,500 electronic invoice submissions per year.

Scientists link recent California droughts and floods to distinctive atmospheric waves. California is one of the many places to have suffered from unforeseen weather emergencies in recent years—extreme drought in the 2013–2015 winter seasons and drenching storms causing floods and mudslides this past winter. Scientists at the National Center for Atmospheric Research (NCAR) have discovered a wave pattern, wavenumber-5, that emerges in the upper atmosphere and circles the globe. This pattern may sometimes make droughts or floods in local areas, such as California, more likely to occur.

Increasing our understanding of the wave pattern, its formation, seasonal nature, and strength holds the promise of better understanding and predicting weather patterns in California and around the world.



The black curves illustrate the jet streams that trap and focus wavenumber-5. The high- and low-pressure regions of wavenumber-5 set up in different locations during January 2014, when California was enduring a drought, and January 2017, when it was facing floods. The location of the high- and low-pressure regions (characterized by anticylonic vs. cyclonic upper-level air flow) can act to either suppress or enhance precipitation and storms. *Credit: Haiyan Teng and Grant Branstator, ©UCAR*

In accordance with the Chief Financial Officers Act of 1990 and the Government Management Reform Act of 1994, NSF prepares financial statements in conformity with U.S. generally accepted accounting principles for federal entities. The financial statements present NSF's detailed financial information relative to its mission and the stewardship of those resources entrusted to the agency. It also provides readers with an understanding of the resources that NSF has available, the cost of its programs, and the status of resources at the end of the fiscal year. NSF's financial statements have undergone an independent audit to ensure that they are free from material misstatement and can be used to assess NSF's financial status and related financial activity for the year ending September 30, 2017.

NSF received an unmodified audit opinion on its financial statements, and no material weaknesses or significant deficiencies were identified in the internal control program for financial reporting. The Independent Auditor's Report begins on page Financials-3. Management's response follows the audit report.

Understanding the Financial Statements

The following discussion of NSF's financial condition and results of operations should be read together with the FY 2017 financial statements and accompanying notes, found in chapter 2, *Financials*, of this AFR.

NSF's FY 2017 financial statements and notes are presented in accordance with OMB Circular No. A-136, *Financial Reporting Requirements*. NSF's current year financial statements and notes are presented in a comparative format. The Stewardship Investment schedule presents information over the last 5 years. Table 1.2 summarizes the changes in NSF's financial position in FY 2017.

Table 1.2 – Changes in NSF's Financial Position in FY 2017
(Dollars in Thousands)

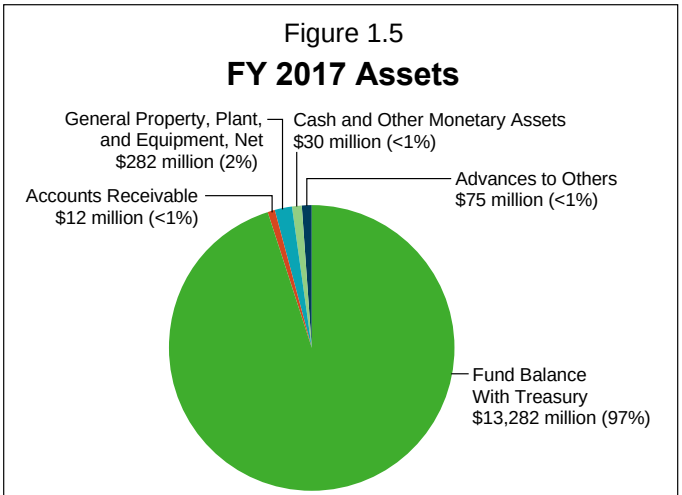
Net Financial Condition	FY 2017	FY 2016	Increase/(Decrease)	% Change
Assets	$13,681,518	$13,330,617	$350,901	2.6%
Liabilities	$494,445	$608,725	– $114,280	– 18.8%
Net Position	$13,187,073	$12,721,892	$465,181	3.7%
Net Cost	$7,116,204	$7,046,347	$69,857	1.0%

Balance Sheet

The Balance Sheet presents the total amounts available for use by NSF (assets) against the amounts owed (liabilities) and amounts that comprise the difference (net position). NSF's total assets are largely composed of *Fund Balance with Treasury*. A significant balance also exists in the *General Property, Plant, and Equipment, Net* account.

In FY 2017, Total Assets (Figure 1.5) increased 2.6 percent from FY 2016. Most of this change occurred in the *Fund Balance with Treasury* account, which increased by $310.6 million in FY 2017. NSF is authorized to use *Fund Balance with Treasury* to make expenditures and pay amounts due through the disbursement authority of the Department of Treasury. The *Fund Balance with Treasury* is increased through appropriations and collections and decreased by expenditures and rescissions.

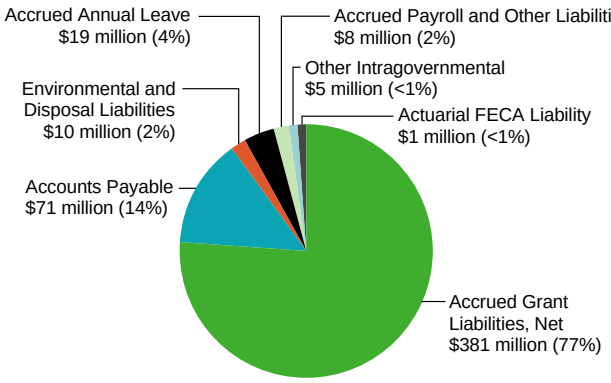
Figure 1.5



In FY 2017, Total Liabilities (Figure 1.6) decreased 18.8 percent from FY 2016. This change was primarily related to a $74.7 million decrease in *Accounts Payable* in FY 2017. *Accounts Payable* is estimated annually by utilizing historical data based on the actual expenses incurred but not reported, as a percentage of current fiscal year expenses. The majority of the FY 2017 change was due to a change in the methodology used to estimate *Accounts Payable*, resulting in a lower *Accounts Payable* as compared to FY 2016.

Statement of Net Cost

Figure 1.6
FY 2017 Liabilities



Note: Totals may not add due to rounding.

The Statement of Net Cost presents the annual cost of operating NSF programs. The net cost of operations of each NSF program equals the program's gross cost less any offsetting revenue. Intragovernmental earned revenues are recognized when related program or administrative expenses are incurred. Earned revenue is deducted from the full cost of the programs to arrive at the Net Cost of Operation.

Approximately 95 percent of all current year NSF Net Costs of Operations incurred were directly related to the support of R&RA, EHR, MREFC, and Donations and Dedicated Collections. Additional costs were incurred for indirect general operation activities (e.g., salaries, training, and activities related to the advancement of NSF information systems technology) and activities of the NSB and the OIG. These costs were allocated to R&RA, EHR, MREFC, and Donations and Dedicated Collections and account for 5 percent of the total current year Net Cost of Operations (Figure 1.7). These administrative and management activities are focused on supporting the agency's program goals.

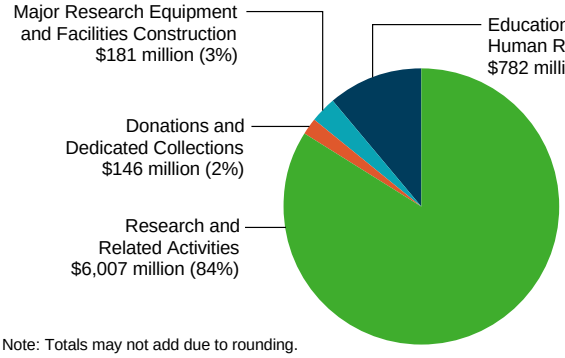
Statement of Changes in Net Position

The Statement of Changes in Net Position presents the agency's cumulative net results of operation and unexpended appropriations for the fiscal year. NSF's Net Position increased by 3.7 percent, or $465.2 million, in FY 2017.

Statement of Budgetary Resources

This statement provides information on how budgetary resources were made available to NSF for the year and the status of those budgetary resources at year end. For FY 2017, *Total Budgetary Resources* decreased $36.3 million from the FY 2016 level. *Budgetary Resources—Appropriations* for the R&RA, EHR, and MREFC accounts were $6,005.6 million, $873.1 million, and $214.9 million, respectively. The combined *Budgetary Resources—Appropriations* in FY 2017 for the NSB, OIG, and AOAM accounts totaled $378.7 million. NSF also received funding via warrant from the H-1B Nonimmigrant Petitioner Account (H-1B) in the amount of $138.1 million and via donations from foreign governments, private companies, academic institutions, nonprofit foundations, and individuals in the amount of $40.9 million. In FY 2017, the *Budgetary Resources—Appropriations* line was also affected by H-1B sequestration in the amount of $9.7 million.

Figure 1.7
FY 2017 Net Cost



Note: Totals may not add due to rounding.

Stewardship Investments

NSF-funded investments yield long-term benefits to the general public. NSF investments in research and education produce quantifiable outputs, including the number of awards made and the number of researchers, students, and teachers supported or involved in the pursuit of science and engineering research

and education. NSF incurs stewardship costs as part of its longstanding commitment to invest in learning and discovery. In FYs 2017 and 2016, these costs amounted to $364.0 million and $371.2 million, respectively.

Limitations of the Financial Statements

In accordance with the guidance provided in OMB Circular No. A-136, NSF discloses the following limitations of the agency's FY 2017 financial statements. The principal financial statements are prepared to report the financial position and results of operations of NSF, pursuant to the requirements of 31 U.S.C. 3515(b). The statements are prepared from the books and records of NSF in accordance with federal *Generally Accepted Accounting Principles (GAAP)* and the formats prescribed by OMB. Reports used to monitor and control budgetary resources are prepared from the same books and records. The financial statements should be read with the realization that they are for a component of the U.S. Government.

Other Financial Reporting Information

Debt Collection Improvement Act of 1996

Net Accounts Receivable totaled $12.1 million at September 30, 2017. Of that amount, $9.8 million was due from other federal agencies. The remaining $2.3 million was due from the public. NSF fully participates in the Department of the Treasury Cross-Servicing Program. In accordance with the Debt Collection Improvement Act, as amended by the DATA Act, this program allows NSF to refer debts that are delinquent more than 120 days to the Department of the Treasury for appropriate action to collect those accounts. In accordance with M-04-10, *Memorandum on Debt Collection Improvement Act Requirements*, NSF writes off delinquent debt more than 2 years old. Additionally, NSF seeks Department of Justice concurrence for action items over $100,000.

Cash Management Improvement Act of 1990

In FY 2017, NSF had no awards covered under Cash Management Improvement Act Treasury-State Agreements. The timeliness of NSF's payments to grantees through its payment systems makes the timeliness of payment issue under the Act essentially not applicable to the agency. No interest payments were made in FY 2017.

Federal Civil Penalties Inflation Adjustment Act of 1990

The Federal Civil Penalties Inflation Adjustment Act Improvements Act of 2015 (the 2015 Act; Sec. 701 of Public Law [P.L.] 114–74) further amended the Federal Civil Penalties Inflation Adjustment Act of 1990 (P.L. 104–410) to improve the effectiveness of civil monetary penalties and to maintain their deterrent effect. The 2015 Act requires

By age 6, gender stereotypes can affect girls' choices. Women account for more than half the U.S. population but only 30 percent of those employed as scientists and engineers in the country. Researchers are investigating several possible factors that contribute to this disparity—including the societal stereotype that associates intellectual talent more closely with men than women.

Stereotypes are powerful. They often influence the types of careers people see themselves in and ultimately choose. Previous research shows that society associates not only ability in math and science with men and boys but also the notion of being "brilliant"—of having raw brainpower. This research evaluated the beliefs of 5-, 6-, and 7-year-old boys and girls about gender and brilliance. Findings highlight the importance of reducing gender disparities by showing how we are influenced by society, especially when we are extremely young.

Stereotypes can influence educational and career paths. *Credit: ©Alesia.* Kan/Shutterstock.com.

agencies to (1) adjust the level of civil monetary penalties with an initial "catch-up" adjustment through an interim final rulemaking and (2) make subsequent annual adjustments for inflation. Inflation adjustments are to be based on the percent change in the Consumer Price Index for all Urban Consumers (CPI-U) for the month of October preceding the date of the adjustment, relative to the October CPI-U in the year of the previous adjustment.

The only civil monetary penalties within NSF's jurisdiction are those authorized by the Antarctic Conservation Act of 1978, 16 U.S.C. 2401, et seq., and the Program Fraud Civil Remedies Act of 1986, 31 U.S.C. 3801, et seq.

Table 1.3 – FY 2017 Civil Monetary Penalty Adjustment for Inflation

Statutory Authority	Penalty (Name or Description)	Year Enacted	Latest Year of Adjustment (via Statute or Regulation)	Current Penalty Level ($ Amount or Range)	Location for Penalty Update Details
Antarctic Conservation Act of 1978, as amended	Knowing violations	1978	2017	$27,950	82 FR 3363-01 Wednesday, January 11, 2017
Antarctic Conservation Act of 1978, as amended	Not knowing violations	1978	2017	$16,516	82 FR 3363-01 Wednesday, January 11, 2017
Program Fraud Civil Remedies Act of 1986	Violations	1986	2017	$10,957	82 FR 3363-01 Wednesday, January 11, 2017

Systems, Controls, and Legal Compliance

Management Assurances

The Federal Managers' Financial Integrity Act (FMFIA)[20] requires that agencies conduct evaluations of their systems of internal control and provide reasonable assurance annually to the President and the Congress on the adequacy of those systems. Internal control is an integral component of an organization's management that provides reasonable assurance of effective and efficient operations, reliable financial reporting, and compliance with laws and regulations.

The FMFIA assurance statement provides management's assessment of the efficacy of the organization's internal control to support effective and efficient programmatic operations, reliable financial reporting, and compliance with applicable laws and regulations (FMFIA§2) and of whether financial management systems conform to financial systems requirements (FMFIA§4).

The FY 2017 unmodified Statement of Assurance is the culmination of the efforts of NSF management's assessment of the design, implementation, and operating effectiveness of its system of internal control. For FY 2017, NSF's internal control assessment provides reasonable assurance that the objectives of the FMFIA and the Federal Financial Management Improvement Act of 1996 (FFMIA) were achieved and also concludes that the internal control processes over financial reporting are effective.

National Science Foundation

FY 2017 Statement of Assurance

The National Science Foundation (NSF) management is responsible for managing risks and maintaining effective internal control to meet the objectives of Sections 2 and 4 of the Federal Managers' Financial Integrity Act (FMFIA). The NSF conducted its assessment of risk and internal control processes in accordance with OMB Circular No. A-123, *Management's Responsibility for Enterprise Risk Management and Internal Control*. Based on the results of the assessment, NSF can provide reasonable assurance that internal control over operations, reporting, and compliance was operating effectively as of September 30, 2017.

/s/
France A. Córdova
Director

November 14, 2017

Highlights from NSF's FY 2017 Internal Control Quality Assurance Program

The Internal Control Quality Assurance Program is responsible for the NSF internal control review process. The internal control review process supports NSF's strategic goal to *excel as a federal science agency*. Excelling as a federal science agency is essential to achieve and carry out NSF's mission and accomplish the other two strategic goals: (1) *transform the frontiers of science and engineering* and (2) s*timulate innovation and address societal needs through research and education*.

[20] FMFIA: https://obamawhitehouse.archives.gov/omb/financial_fmfia1982.

In FY 2017, NSF continued its efforts to enhance its internal control review program and further implement the guidance in OMB Circular A-123, *Management's Responsibility for Enterprise Risk Management and Internal Control*,[21] the GAO *Standards for Internal Control in the Federal Government* (known as the Green Book),[22] and the Committee of Sponsoring Organizations of the Treadway Commission (COSO) *Internal Control—Integrated Framework (2013)*.[23] To ensure compliance with the Green Book and the COSO framework, NSF performed an entity-level assessment comprised of interviews and data gathering through questionnaires administered to key members of NSF management. The assessment validated NSF's compliance with the Green Book and COSO frameworks.

NSF sought to gain efficiencies in testing processes by approaching the program as a value-added management function for the agency. For FY 2017 the business process review approach consisted of two general tracks: corrective actions and management assurance.

The corrective actions track focused on the remediation activities related to the significant deficiency and control deficiencies identified during the FY 2016 financial statement audit. NSF developed and validated corrective actions to address issues highlighted in the FY 2016 financial statement audit. This activity included:

- efforts to eliminate the IT significant deficiency (iTRAK, Awards, and WebTA);
- strengthening user controls over third party service providers;
- documenting and strengthening internal controls over undelivered orders; and
- process improvements to the grant accruals methodology, including adjustments in the use of historical data.

For the management assurance track, NSF focused on testing and evaluating its business processes. In conducting its assessment of internal control over agency operations, reporting, and compliance with applicable laws and regulations, NSF applied an agile and multi-year approach.

In addition to the existing internal control review process, FY 2017 activities were expanded into two new areas: (1) DATA Act compliance and (2) Fraud Reduction and Data Analytics Act of 2015 (FRDAA) requirements. NSF conducted an audit readiness assessment for the control design related to the DATA Act reporting implementation and for compliance with the DATA Act requirements. NSF evaluated whether the internal controls over spending data were properly designed, implemented, and operating effectively to manage and report financial and award data in accordance with the DATA Act. NSF used iterative reviews to determine if there were opportunities for improving the control environment to support the organization's implementation and compliance with the DATA Act. These observations addressed the design elements, which focused both on complying with DATA Act requirements and ensuring that NSF is continually improving its readiness for future audits from the agency's OIG. The assessment yielded opportunities in several areas including validating data, improving controls, and better documenting and communicating decisions and policy.

Implementation activities related to FRDAA are discussed in *Appendix 3: Fraud Reduction Report* of this AFR.

Internal Control over Financial Reporting—OMB Circular A-123, Appendix A

NSF's FY 2017 review for Internal Control over Financial Reporting consisted of tests of operational effectiveness and tests of control design. NSF evaluated the key controls to ensure they were functioning properly to mitigate risks of material misstatements in the financial reports and to support NSF

[21] OMB Circular A-123: https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/memoranda/2016/m-16-17.pdf
[22] GAO *Standards for Internal Control in the Federal Government*: http://www.gao.gov/products/GAO-14-704G.
[23] COSO Internal Control Integrated Framework: https://www.coso.org/Pages/ic.aspx

management's financial reporting assertions. The process areas tested for operational effectiveness were Grants Management, Large Facilities Oversight, Travel Systems, Procure to Pay, and Financial Reporting alignment with DATA Act submission processes. As part of the test of design, NSF assessed whether key controls performed properly and whether the controls addressed the control object and business risk. The process areas tested for control design were undelivered orders, DATA Act implementation, and user controls over third party service providers.

Based on the results of the assessment, NSF provides reasonable assurance that its internal control over financial reporting is operating effectively and no material weaknesses were identified.

Improving the Management of Government Charge Card Programs—OMB Circular A-123, Appendix B

In FY 2017, NSF conducted a fraud risk assessment of travel and purchase cards, developed a fraud risk profile and response plan, and created a proof-of-concept for developing a data analytics capability to better identify potential risk exposures in the travel and purchase card programs.

To conduct the risk assessment, NSF reviewed internal controls and policy documentation for the travel and purchase card programs. NSF administered surveys, conducted interviews, and facilitated focus groups with staff from various divisions within NSF, while evaluating charge card program risks. In addition to performing the risk assessment, NSF developed and employed various data analytics to examine travel and purchase card data. The analytics enabled NSF to identify trends in the data and build prototype dashboards that could aid in NSF's monitoring of travel and purchase cards.

The fraud risk assessment reviewed purchase cards and identified a finding consistent with the repeat finding from the internal control reviews; specifically, a need for periodic reviews to determine whether each purchase cardholder has a need for the purchase card. The recommendation is to increase monitoring of the issuance of purchase cards to ensure that resources are allocated in the most efficient and effective manner.

In addition to conducting the fraud risk assessment and ensuring OMB Circular A-123, Appendix B compliance, NSF assessed the status of the corrective action plans from the FY 2016 review and completed an Appendix B crosswalk to ensure NSF has maintained the appropriate internal controls to reduce the risk of fraud, waste, and error within the charge card program. The review of the Appendix B crosswalk ensured that NSF is in compliance with the following sources:

- P.L. 112–194, Government Charge Card Abuse Prevention Act of 2012;
- OMB Memorandum *M-12-12, Promoting Efficient Spending to Support Agency Operations;* and
- OMB Circular A-123, *Appendix B, Improving the Management of Government Charge Card Programs.*

Based on the results of the assessment, NSF provides reasonable assurance that internal control processes related to the Government Charge Card Programs are operating effectively, and no material weaknesses were identified.

Requirements for Effective Estimation and Remediation of Improper Payments—OMB Circular A-123, Appendix C

During early FY 2017, NSF completed a qualitative risk assessment of FY 2016 improper payments. The risk assessment determined NSF did not have significant risk of improper payments for grants, contracts, charge cards, and payroll payments. In May 2017, the NSF OIG issued a report on NSF's compliance with the improper payment requirements for FY 2016. The OIG concluded NSF complied with the requirements and had addressed all recommendations from the previous OIG report. This was the second consecutive

report finding NSF in compliance with improper payment reporting requirements. The May 2017 OIG report had no recommendations and no resolution tracking requirements. The two reports validate that NSF has taken the steps necessary to demonstrate compliance and effectiveness in the agency's implementation of improper payment requirements. NSF will conduct an improper payment risk assessment in FY 2018.

Based on the results of the OIG's assessment, and NSF management's efforts to eliminate improper payments, NSF provides reasonable assurance related to the OMB Circular A-123, Appendix C requirements.

Compliance with the Federal Financial Management Improvement Act of 1996—OMB Circular A-123, Appendix D

NSF is required by Appendix D of OMB Circular A-123, *Compliance with the Federal Financial Management Improvement Act of 1996*, to implement and maintain financial management systems that substantially comply with Federal Financial Management System Requirements, federal accounting standards, and the U.S. Standard General Ledger (USSGL) at the transaction level.

NSF reviewed business processes and completed the FFMIA Compliance Determination Framework, to validate compliance with the following requirements, as outlined in Circular A-123, Appendix D:

- NSF developed and maintains financial management systems, in accordance with Circular A-130 and Circular A-123.
- NSF's financial management systems comply with the policies prescribed in Appendix D, as well as associated financial management system guidance.
- NSF established a remediation plan identifying resources, remedies, and target dates to bring NSF's financial management system into compliance.
- Report, if needed, compliance with the Federal Financial Management System Requirements, federal accounting standards, and USSGL at the transaction level through the reporting structure established by Section VI of Circular A-123.

NSF performed remediation efforts to resolve the financial statement audit IT significant deficiency related to the iTRAK, Awards and WebTA systems. NSF actively monitored and addressed the issues identified in the audit. In addition, NSF verified and validated corrective action plan efforts based on testing results. NSF also strengthened user controls over third party service providers. NSF regularly assesses the design and operating effectiveness of the service organization's internal controls, including IT general controls and all five GAO Green Book components of internal control. NSF management established user controls to monitor the process for effectiveness. In FY 2017, NSF performed remediation efforts to document procedures for ensuring the adequacy of controls over third party service providers.

NSF has established a comprehensive IT security program that is consistent with the Federal Information Security Modernization Act of 2014 and industry best practices. NSF's IT controls are effective in maintaining a secure IT environment and align with the National Institute of Standards and Technology Framework for Improving Critical Infrastructure. The agency's IT environment is supported by a suite of comprehensive policies and procedures that incorporate federal mandates and guidance. NSF has a strong Information Security Continuous Monitoring program that includes the Department of Homeland Security Continuous Diagnostic and Mitigation technologies. The OMB Cybersecurity Risk Management Assessment evaluated NSF's overall cybersecurity risk management and confirmed that NSF has effective IT security controls in place.

Based on the results of the assessment, NSF provides reasonable assurance that internal control processes related to FFMIA—OMB Circular A-123, Appendix D, are operating effectively, and no material weaknesses were identified.

Other Federal Reporting and Disclosures

Anti-Deficiency Act (ADA): NSF is not aware of any ADA violations that are required to be reported for the year ended September 30, 2017.

Pay and Allowance System for Civilian Employees, provided primarily in Chapters 31–50 of Title 5, U.S.C.: The Department of the Interior, Interior Business Center (IBC) Federal Personnel/Payroll System (FPPS) is a Shared Service Provider and performs many of NSF's payroll functions. IBC FPPS's internal control is annually reviewed by auditors under the Statement on Standards for Attestation Engagements (SSAE-18). IBC FPPS's controls are found to be suitably designed and operating effectively. This conclusion is based partly on transactional testing.

Prompt Payment Act: The Prompt Payment Act mandates interest penalties on payments over 30 days. Under OMB *Memorandum 17-27, Reducing Burden for Federal Agencies by Rescinding and Modifying OMB Memoranda*, NSF is encouraging accelerating payments to all contractors within 15 days of a proper invoice being received. This acceleration allows small business contractors to be paid as quickly as possible. NSF's Prompt Payment Rate was consistently above 95 percent during this fiscal year.

Government Charge Card Abuse Prevention Act of 2012, P.L. 112–194: The act requires that agencies ensure that appropriate policies and controls are in place or that corrective actions have been taken to mitigate the risk of fraud and inappropriate charge card practices. NSF provides reasonable assurance that internal controls related to the Government Charge Card Programs are operating effectively, and no material weaknesses were identified. Additional information is provided above in *Improving the Management of Government Charge Card Programs—OMB Circular A-123, Appendix B*, page MD&A-23.

Provisions Governing Claims of the U.S. Government (31 U.S.C. 3711–3720E) (Including the Debt Collection Improvement Act of 1996): The Debt Collection Improvement Act is addressed on page MD&A-19

Federal Information Security Modernization Act Management Act of 2014: This topic is addressed in subsection *Compliance with the Federal Financial Management Improvement Act of 1996—OMB Circular A-123, Appendix D*, page MD&A-24.

Single Audit Act of 1984, P.L. 98–502, and the Single Audit Act Amendments of 1996, P.L. 104–156. (A-136, section II.2.8): The Single Audit Act requires financial statement audits of non-federal entities receiving or administering grant awards with federal expenditures exceeding $750,000 during its fiscal year. Federal agency internal control standards determine whether award expenditures comply with laws and regulations. NSF, similar to other federal agencies, is required to review the findings and recommendations of audit reports for funding recipients to determine whether corrective actions (if required) are adequate and implemented. NSF utilizes guidance from the *OMB Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards (Uniform Guidance)*[24] and *Audit Follow-up*[25] as a basis for its audit resolution and follow-up activities. During FY 2017, NSF resolved 192 single audit reports.

[24] Uniform Guidance (2 CFR 200): https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=fd67dcb2fb543c275053150a6352be38&mc=true&n=pt2.1.200&r=PART&ty=HTML
[25] Audit Follow-up (OMB Circular A-50): https://www.whitehouse.gov/omb/circulars_a050.

NSF continues to ensure that its policies and procedures fully align with federal requirements. The agency continually assesses the effects changes in policies and practices (e.g., increase in single-audit thresholds, risk management, streamlining of federal requirements, timeliness) may have on NSF's stewardship over its investments. NSF continues to strengthen audit resolution and other oversight functions by deepening subject matter expertise of its staff and the effective utilization of available resources. In addition, NSF maintains formal, ongoing dialogue with the OIG to address issues affecting audit resolution (e.g., new methodologies), as well as the interpretation and application of NSF policies and procedures.

Financial System Strategy and Framework

Financial System Strategy

The goals for NSF's 3-year-old core financial system align with NSF's strategic goal in that iTRAK's goals are to increase capabilities for more informed decision making to further science and innovation and to excel as a federal science agency by improving financial effectiveness and accountability for the public benefit. iTRAK ensures that transactions are posted in accordance with the USSGL at the transaction level; maintains accounting data to permit reporting in accordance with *GAAP* as prescribed by the Federal Accounting Standards Advisory Board; enforces strict funds control across the budgeting and spending functions to prevent ADA violations; and enables strong access control and definition of "responsibilities" to support segregation of duties control. iTRAK complies with OMB Memorandum M-10-26, *Immediate Review of Financial Systems IT Projects*; OMB Memorandum M-13-08, *Improving Financial Systems through Shared Services*; and OMB Circular A-123, Appendix D.

Also key to NSF's financial system strategy is leveraging iTRAK to support agency compliance with federal mandates. For example, NSF continues to evaluate, test, and plan for the implementation of the Oracle DATA Act patches so that the DATA Act required files can be created directly from iTRAK. Additionally, the new financial system enabled NSF to successfully implement Treasury's web-based e-Invoicing system, IPP, in compliance with OMB M-15-19, *Improving Government Efficiency and Saving Taxpayer Dollars through Electronic Invoicing*.

NSF continues to strengthen iTRAK with a focus on (1) maturing iTRAK system and business processes to improve operational efficiencies, (2) training users to improve skills in targeted functionalities, (3) providing financial data to the agency's data warehouse to enable users to combine financial and programmatic data for more informed decision making, and (4) strengthening controls over system processes including security controls.

As iTRAK matures, NSF will continue to expand its analytical capabilities toward a more performance-driven system to better support NSF's mission. Competing priorities coupled with limited resources continue to be key challenges facing the Foundation. Senior leadership will continue to work with internal and external stakeholders to agree on the order of priorities while managing risk.

Financial Management System Framework

NSF's financial management system framework (Figure 1.8) focuses on the Foundation's financial management systems, standard business processes, data, and information architecture to ensure reliable, timely, and consistent financial information that enables effective management of NSF resources and delivery of mission critical products and services.

NSF's core financial system, iTRAK, interfaces with NSF's awards, grants management, and business process systems including:

- Award Cash Management Service (ACM$).
- Award Management and Award Letter System ("Awards").

- eJacket, NSF's internal awards processing system.
- Research.gov and FastLane, NSF's websites through which researchers, research administrators and their organizations, and reviewers interact with NSF.
- Graduate Research Fellowship Program System (GRFP).
- Guest Travel and Reimbursement System.

iTRAK also interfaces with external systems operated by the U.S. Department of the Treasury; JPMorgan Chase Bank; and LearnNSF, the Foundation's training system, and with other federal systems such as the FPPS, eTravel/Concur, and GSA's System for Award Management.

Figure 1.8—NSF Financial Management System Framework