STRATEGIC OBJECTIVE PROGRESS UPDATES

In FY 2015, the National Science Foundation conducted seven Strategic Reviews in response to the requirement of the GPRA Modernization Act 2010 Section 1116(f). This section summarizes the status of the actions that NSF plans to take in response to the Strategic Review recommendations.

Strategic Goal 1: Transform the Frontiers of Science and Engineering.
Strategic Objective 1: Invest in fundamental research to ensure significant continuing advances across NSF science, engineering, and education.

The Strategic Review examined mechanisms that NSF can use to overcome the barriers of our traditional, discipline-based organizational structure to advance science at the intersections of disciplines. Available metrics and tools within NSF were used to assess the current status of funding for multidisciplinary research.

1. Are there effective metrics and tools within NSF to evaluate if a proposal or award involves multiple disciplines?

2. Are there sufficient opportunities and effective mechanisms for the research community to submit proposals that involve multiple disciplines, both within and outside of core programs at NSF?

   The Strategic Review used several approaches to investigate whether NSF has effective tools to track multi-disciplinary research. One approach compared different mechanisms of identifying multidisciplinary proposals using proposal and award data from one division. Proposals were classified based on principal investigators (PI) self-classification, program reference codes, the disciplines of the PIs, disciplines of reviewers, co-funding between directorates, and text searchers for the term "interdisciplinary." Estimates of the percentage of proposals that were interdisciplinary using different indicators varied between 12 and 61 for this sample of proposals. Indicators where the PIs classify their own proposals suggest higher percentages of multi-disciplinarity.

   Using the most conservative of these indicators, an analysis was done with a random sample of 20,000 proposals submitted to NSF between CY 2010 and CY 2014. This NSF-wide analysis using the involvement of multiple investigators from different academic departments as the indicator of multi-disciplinarity found that the percentage of proposals submitted that involved multiple divisions varied little over the past five years, and varied only modestly across directorates, with an average of 16 percent. This indicator clearly under-reported the number of multi-disciplinary proposals in programs where proposals were known to be multi-disciplinary. The conclusion from these analyses was that NSF does not currently have appropriate indicators to allow meaningful analyses of multi-disciplinary research.

Opportunities for Action or Improvement

- Develop effective assessment and data tracking methods such that NSF can objectively evaluate research involving multiple disciplines.

Strategic Goal 1: Transform the Frontiers of Science and Engineering.
Strategic Objective 2: Integrate education and research to support development of a diverse STEM workforce with cutting-edge capabilities.

NSF has determined that performance towards this objective is making noteworthy progress.

The Strategic Review examined the strengths and weaknesses of NSF's three primary graduate support mechanisms: research assistantships, fellowships, and traineeships.

1. With its current ratio of 80 percent research assistantships, 15 percent fellowships, and five percent traineeships, is NSF meeting the objectives of G1/O2?

2. What are the strengths and weaknesses of the three primary graduate support mechanisms employed by NSF? What are the ratios of graduate support mechanisms by discipline?

   The Strategic Review used evidence and information provided by external evaluations of NSF programs, National Center for Science & Engineering Statistics (NCSES) published reports, a special tabulation of data from the NCSES Survey of Earned Doctorates, reports from professional associations, and other sources to answer the key analytical questions.

   The primary mechanisms of NSF graduate support are research assistantships (RAs) linked to individual investigator awards (less than five percent are linked to Centers or similar types of programs), fellowships (directly awarded to the graduate student to support their own research), and traineeships (awarded to an institution to support graduate students participating in a particular research program). Recent high-profile reports have stated that the current graduate support system rests too heavily on individual research grants and that a shift to more multiple-year fellowships and traineeships is warranted, returning to a more balanced system of graduate student support similar to that of the 1960s.[1,2] These reports are generally critical of RAs, with statements such as "students on research grants are not necessarily provided with the kinds of programmatic commitment to success, alignment with 21st-century careers, and professional development activities that are components of training grants."[1]

   The sources of evidence that were reviewed suggest that all support mechanisms have been successful in preparing students for the workforce. Although some data exists to understand the impacts of both fellowships and traineeships, and there are some data for center-based RAs, to date there has been no comprehensive data collection across all three graduate support mechanisms to assess the strengths and weaknesses of each approach. To better understand NSF's portfolio of graduate support, the agency should undertake a careful analysis of the relative merits and risks of each support mechanism.

   Numerous factors will complicate this assessment. During their tenure in graduate school, most students are supported by more than one type of funding mechanism that may come from a number of sources and for only part of the academic year.[3] There are also more sources of support than RAs,

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[1] *Research Universities and the Future of America: Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security.* Committee on Research Universities; Board on Higher Education and Workforce; Policy and Global Affairs; National Research Council. (2012).
[2] *Advancing Graduate Education in the Chemical Sciences.* Summary Report of an ACS Presidential Commission. American Chemical Society. (2013).
[3] *Special tabulation of data from the Survey of Earned Doctorates.* National Science Foundation, National Center for Science and Engineering Statistics. March 2015.

traineeships, and fellowships. Graduate students can also be supported on teaching assistantships (TA), scholarships, and/ or self-supported through their own resources.[4] Another complication is that the ratios of support mechanisms differ greatly by discipline,[4] though there are few data to determine the primary cause driving these differences, such as whether they are resulting from external constraints, whether they have developed organically in response to the needs of the respective research communities, or a combination of both. Biological sciences have the highest percentage of traineeships (eight percent) relative to all funding sources (including teaching assistants, self-support and "other") with all other disciplines having less than three percent. The percent of fellowship support is relatively constant between five percent and 14 percent across most disciplines. Psychology and computer science have high percentages of self-support (~50 percent) whereas biological sciences, physical sciences, geoscience, and mathematics have 25 percent or less.

3. Are certain mechanisms of NSF graduate student support more effective in increasing diversity of the STEM workforce?

   Amalgamated data across all disciplines from CY 2009 to CY 2013 show that RAs, fellowships/scholarships, and TAs are the dominant support mechanisms for all racial/ethnic groups, with American Indian/Alaska Native and Black students also having significant funding coming from their personal savings and loans (23 percent to 25 percent).[3] These data also indicate that for all underrepresented groups, fellowships/scholarships are the primary means of support in graduate school (32 percent to 39 percent of doctoral graduates), with RAs (15 percent to 24 percent) and TAs (10 percent to 13 percent) providing less support. Significant differences in the proportion of underrepresented groups across disciplines means that amalgamated demographic data mask graduate support differences among disciplines.[5] Nevertheless, even when analyzing data on fellowship support provided to underrepresented groups by discipline, there is a strong indication that this mechanism is effective in increasing diversity in science and engineering doctoral recipients.[6] Data also show that, since RAs are open to foreign students and other graduate support mechanisms are not, permanent residents (40 percent) and temporary residents (54 percent) rely more heavily on RA support as compared to U.S. citizens (27 percent).[3] Unfortunately, with available data it is not possible to determine the level to which RA support of foreign students is impacting this avenue for supporting underrepresented groups.[3]

   When considering differences in gender, for those disciplines where the number of male to female doctoral candidates is similar or less than 1:2, the distribution of funding across all types of support is nearly equal. For those disciplines where females are a clear minority, the fellowship/scholarship support of female graduate students increases to similar levels as underrepresented groups.[5]

Opportunities for Action or Improvement

- Initiate a data collection using a common, well-documented methodology that will allow comparisons across all three graduate support mechanisms.
- Analyze current approaches that aim to improve graduate student preparedness for entering the workforce beyond traditional roles in academia.
- Understand how awardee institutions position graduate students for future careers and identify NSF programs that contribute to these types of training activities. Support workshops to discuss effective

[4] Tables 35-41, *Survey of Graduate Students and Postdoctorates in Science and Engineering (2012).* National Science Foundation, National Center for Science and Engineering Statistics.

[5] Tables 35-41, *Doctorate Recipients from U.S. Universities: 2012. Special Report NSF 14-305.* National Science Foundation, National Center for Science and Engineering Statistics. 2012. Arlington, VA. Available at www.nsf.gov/statistics/sed/2012/.

[6] *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2015.* National Science Foundation, National Center for Science and Engineering Statistics. 2015. Special Report NSF 15-311. Arlington, VA. Available at www.nsf.gov/statistics/wmpd/.

practices for ensuring graduate preparedness. Support pilot programs of new concepts in broadening graduate skills.
- Explore whether additional investments in fellowships targeting increasing diversity would further the goals of G1/O2.

In their cross-cutting assessment of the Strategic Review results, the Performance Improvement Officer (PIO) and Chief Operating Officer (COO) determined that activities initiated in response to these recommendations should be tracked as an Agency Priority Goal.

Strategic Goal 1: Transform the Frontiers of Science and Engineering
Strategic Objective 3: Provide world-class research infrastructure to enable major scientific advances.

Much of today's scientific research is interdisciplinary, data-intensive, and global. Advances often occur through the involvement of large teams working across sites on shared datasets. Cyberinfrastructure, a critical component of research infrastructure, is acting as a catalyst for that change. The purpose of this Strategic Review was to examine NSF activities and roles regarding supporting "Next Generation Research Infrastructure" (NGRI). As a first step, the Strategic Review Team began by defining NGRI.

1. What are some attributes of the Next Generation of Research Infrastructure (NGRI)?

2. How will NGRI change research?

   For the purpose of this review, Research Infrastructure (RI) was defined as any combination of facilities, tools (physical, computational, or analytical), instrumentation, and human capital assembled in support of advancing scientific knowledge, accelerating technology development, enhancing technological and social innovation, and providing training for the next generation of individuals in the STEM fields. RI may be single-sited or distributed; regional, national, or global. Currently RI does not include NSF-designated Centers, which may use RI to support innovative research and education, encourage knowledge transfer, and promote integrative approaches to interdisciplinary activities.

   NGRI is RI that is increasingly:
   - Collaborative: These collaborations can be national or international. Part of the reason for this is to share costs, but it is also due to the increasing complexity of research questions being addressed in STEM fields.
   - Adaptive and Predictive: Researchers use analytical tools and compute cycles on an as-needed basis. This enables rapid data processing and analysis and results in interpretable and just in time findings for end users.
   - Scalable and Integrated: NGRI is linked and expanded through a "network of networks." It is also integrated across physical (e.g., telescope) and cyber (e.g., data stored in cloud) components.
   - Accessible and Transparent: NGRI employs cyber-enabled, graphical human interfaces for data collection, processing and analysis, and, increasingly, operational control of the RI.

   NGRI changes research by providing unprecedented access to ubiquitous distributed computing, which will enable investigators to answer questions they could not before and replicate research more accurately.

3. What are the barriers and opportunities for supporting and catalyzing NGRI at NSF?

   Barriers for moving towards NGRI at NSF:
   - Perceptions: PIs may perceive barriers by NSF or universities to using NSF awards for NGRI resources. A review of NSF policies produced no evidence of intrinsic barriers to charging NGRI (e.g., cloud resources) as a direct cost. Anecdotal evidence suggests that institutions may vary widely in how they classify NGRI costs.
   - Sociological: Not all research communities have a tradition of sharing data or software, or having others control the research infrastructure, nor are there sufficient social and institutional incentives.
   - Resource mismatch compared to other movers in the field: Industry (e.g., Silicon Valley, oil industry, defense) has advanced capabilities and data that move their research ahead of university-based research. NSF's role in this context should be made clear to its community.

- Human capital: Knowledge and understanding. NGRI may present a significant learning curve. Users need help, often through support of other humans, to harness its potential.

Opportunities for Action or Improvement

- Transition to NGRI: Support a workshop to get community input on funding / support gaps in NGRI portfolio to accelerate the transition to NGRI. Several issues to consider include understanding: sustainability of a NGRI investment, including all RI components; how software defined infrastructure concepts and practice can address issues of extensibility of the infrastructure, interoperability with other infrastructures, and sustainability of the infrastructure; and the role of human capital in NGRI.
- NSF policies with respect to NGRI: Review NSF policies that affect use or development of NGRI, and issue an appropriate communication to community.
- Funding gaps: Initiate internal discussions to reevaluate whether there are funding gaps that might affect the support of NGRI projects.

Strategic Goal 2: Stimulate innovation and address societal needs through research and education.
Strategic Objective 1: Strengthen the links between fundamental research and societal needs through investments and partnerships.

The Strategic Review of this goal and objective considered how access to large-scale, NSF-funded data repositories advances national health, prosperity, and welfare, and the critical barriers to making NSF-funded scientific data more broadly available and enduring. It also examined whether existing NSF mechanisms are sufficient to inform relevant communities about data repositories.

1. How does access to NSF-funded data repositories advance national health, prosperity, and welfare?

   NSF, along with other federal agencies, has funded hundreds of data repositories. Efforts redoubled in 2013 in response to OSTP's call to make publically-funded research more available. Three ways repositories contribute to societal needs are:

   - Access to high quality data encourages innovation by lowering the technical and resource barriers to innovation and engaging a global research community.
   - Expanded access to enduring, quality data expands the accepted scholarly record to include the preservation of the observational, experimental, and computational data that is rapidly accumulating in every field of science.
   - Increased access to data leverages the public research investments that result in data generated by surveys, mobile and embedded systems, sensors, observing systems, scientific instruments, experiments, simulations, evaluations and analyses.

2. What are some of the critical barriers to making NSF-funded scientific data more broadly available and enduring?

   One of the barriers is that infrastructure is limited. There are few existing long-term, deep archives that are readily suitable for data deposit. Tools for search and discovery, and pathways for data transfer to repositories at project end need to be improved. There is also the need for more consistent data citation standards and the use of persistent data identifiers.

   Another barrier is that roles and responsibilities are still evolving and this leads to uncertainty. This is true in the research community regarding data management practices, dissemination, and attribution/re-use. At NSF, roles regarding data policies in proposal review and portfolio management are evolving. Among federal agencies, roles for coordination, planning, and assessing data efforts are also changing.

   Financial resources are needed to address disciplinary/strategic data repository needs, to ensure the sustainability of major NSF-funded community data facilities, and to enable "long tail" continued use of data repositories.

3. What are the mechanisms in place within NSF to inform relevant communities about data repositories, and are they sufficient?

   Several, disparate repository efforts are found across the agency in various programs. The Public Access Plan[7] provides high-level guidance and clearly states NSF's firm commitment to data access and preservation. The Cyberinfrastructure Coordinating and Leadership Group (CLG) is exploring

[7] www.nsf.gov/pubs/2015/nsf15052/nsf15052.pdf

current efforts in data and cyberinfrastructure priorities of the various directorates, and relevant gaps and opportunities.

Opportunities for Action or Improvement

- Refine data management guidance and practices (see, e.g., NSF's Public Access Plan, Sections 7.2.2-7.2.3, 7.3.2, 7.4.2);
- Identify and expand use of partnerships to support creation and sustainability of data management resources.

Strategic Goal 2: Stimulate innovation and address societal needs through research and education.
Strategic Objective 2: Build the capacity of the Nation to address societal challenges using a suite of formal, informal, and broadly available STEM educational mechanisms.

The Strategic Review examined the role that Public Participation in STEM Research (PPSR) can play in advancing science and engineering and increasing the participation of the U.S. population in science and engineering broadly. PPSR is an overarching category for projects that involve partnerships between professional scientists and amateurs and always involves the public's participation in at least some aspects of genuine STEM research. Activities known as "citizen science" and "crowdsourcing science" are both included. The field of PPSR has evolved rapidly from a focus simply on data collection toward a more collaborative enterprise, where participants are increasingly involved in more aspects of the research process.

1. How is 'Public Participation in STEM Research' (PPSR) defined?

2. How can NSF's investments in PPSR be characterized?

3. What cutting-edge investments might NSF make to advance PPSR?

   Citizen science has taken place for centuries in a variety of fields (e.g., Christmas Bird Count, lighthouse weather data, and astronomical observations) but has grown significantly in the past decade, in part due to new technological tools. Similarly, crowdsourcing science refers to processes in which open calls are made for voluntary contributions to STEM problem-solving. These calls are typically either to a non-specified group of individuals ("the crowd") or to individuals with specific expertise, thus leveraging the skills and knowledge of many (e.g., Foldit[8], EyeWire[9]).

   The motivation for PPSR, whether citizen science or crowdsourcing science, may be derived from community concerns or may be scientist-led. NSF has chosen to follow the field in calling these activities PPSR in order to clarify that the focus is on participation in STEM, and should not be confused with an activity that focuses on any individual's (or group's) nationality. In addition, NSF is using "STEM" in lieu of "Scientific" (i.e., "Public Participation in STEM Research") to ensure recognition of this approach in all areas of science and engineering.

   PPSR projects have both scientific and educational value. Without public participants and their contributions, some research would not be practical or even possible (e.g., projects requiring data collection from many geographical locations or over long periods of time, or projects requiring analysis of large sets of visual or numeric data). Moreover, PPSR provides opportunities for people of all genders, races, ethnicities, ages, and geographic locations to learn how STEM research is conducted and to engage in it directly. The level of public involvement varies from being contributory (e.g., collecting and recording data) to collaborative (e.g., analyzing samples and discussing results) to co-created (i.e., in which the public might be involved in all phases of the scientific process from defining the question for investigation, to experimenting, analyzing, and reporting results).

   An analysis of NSF awards active in October 2014, identified 187 projects that included elements of PPSR. Approximately 50 new awards have been funded each year from FY 2012 to FY 2014. Thematically, investments in all disciplines aimed to increase data quality. Development of mobile technologies for sensing and data collection was an interest primarily centered in awards from ENG,

[8] https://fold.it/portal/
[9] http://blog.eyewire.org/about/

CISE, BIO, EHR, and GEO. Not surprisingly, collecting data over large geographic and/or temporal scales was a theme in BIO and GEO awards, whereas understanding how PPSR engages people surfaced as a theme in SBE and EHR awards. A minority of awards contained aspects related to security and privacy (particularly in CISE) or enhancing and measuring learning (particularly in EHR).

Through its awards, NSF has played a seminal role in supporting the expanding field of PPSR in terms of science, technology, and learning. For example, building on NSF investments, the growing community of practice has formed a Citizen Science Association and a new *Citizen Science: Theory and Practice* journal. To continue to advance PPSR, NSF should consider investments in the following:

- Support the Growing PPSR Community of Practice. The field of PPSR has evolved rapidly from a focus simply on data collection toward a more collaborative enterprise, where participants are increasingly involved in more aspects of the research process. NSF should consider investing in efforts to support this community in terms of recruitment, networking, training, data reporting, authorship, and assessment.

- Advance the Technologies and Tools of PPSR. To continue to promote greater levels of public involvement in PPSR, the development of more user-friendly, robust, and affordable sensors for STEM research could be promoted. As more public participants become collaborators in scientific research, many issues related to networking, data management and access, data quality, and crowd-sourced analytics, as well as their scale-up, would need to be addressed.

- Investigate the Contributions of PPSR to Learning. NSF broke ground by funding projects that recognized learning as a key outcome of PPSR projects. The learning aspect of PPSR warrants additional study to understand the demographics and motivations of participants, the extent and nature of STEM learning and engagement, and the most effective strategies for broadening participation in STEM through PPSR experiences.

- Assess the Potential of PPSR to Enable New Fields of Discovery Research. With the opportunity to reach more people and therefore collect and analyze data sets more extensively than possible through the efforts of scientists alone, PPSR may go beyond simply enhancing our ability to do traditional STEM better. PPSR enables us to pursue entirely new avenues of research that can only be achieved through public-scientist collaborations. The different cultural perspectives and habits of mind that public participants can bring to bear on the interpretation of data may also open new avenues of research. This potential is worth exploring.

Opportunities for Action or Improvement
NSF should take the next steps to promote theoretical and empirical research leading toward a 'Science of PPSR.' Analogous to developments in learning in the past, PPSR is moving from a type of activity to be supported to a way of doing research and learning that needs to be understood. The steps in this direction, in priority order, are to:

- Support a workshop on PPSR learning & broadening participation
- Encourage, through existing programs, advances in sensors and communication/data management infrastructure for PPSR.

In their cross-cutting assessment of the Strategic Review results, the PIO and COO determined that activities initiated in response to these recommendations should be tracked as an Agency Priority Goal.

Strategic Goal 3: Excel as a Scientific Federal Agency.
Strategic Objective 1: Build an increasingly diverse, engaged, and high performing workforce by fostering excellence in recruitment, training, leadership, and management of human capital.

Program directors (PDs), including permanent and rotator staff, are the largest and highest-turnover segment of NSF's workforce. The Strategic Review of this goal and objective considered the changes in the PD job duties and workforce over the last 15 years and examined factors impacting recruitment, selection, and retention of PDs. The Strategic Review utilized an array of qualitative and quantitative evidence to support the key findings and recommended actions summarized below.

1. What qualities does NSF seek in program directors?

   Although each directorate seeks a slightly different combination of skills when recruiting program directors, most include skillsets that fall into three categories: 1) technical expertise, 2) management skills (the ability to get things done), and 3) a collaborative mindset. The team noted the increasing importance of non-technical skills in the timeframe considered.

2. How has the program director job changed over the past 15 years?

   Recruitment and retention of program directors is correlated to the changes in the program director job duties over the past 15 years. These changes include increasingly large and complex workloads without proportional staffing changes (proposals up 65 percent, staffing up only 20 percent), use of increasingly complex electronic systems and communications, travel policies, salary and performance award policies, multi-directorate solicitations, and reduced participation in the Independent Research Development (IR/D) program. In addition, the interrelationship between the delays in receiving appropriations, GPRA dwell time goals, time-consuming compliance checking, and end-of-year close-out pressures add to workload concerns.

3. What are the factors impacting recruitment, selection, and retention of a high-performing program director workforce?

   Nineteen percent of NSF's STEM workforce was eligible to retire at the end of FY 2014, with eligibility projected to grow to 32 percent by FY 2018. It is expected that a significant fraction of these people will choose to retire at the time of or prior to NSF's move to Alexandria. In the 2014 FEVS results, the STEM workforce reported having unreasonable workload levels more often than any other NSF job family. The team identified a range of professional, personal, and environmental/logistical factors that affect recruitment and retention in both positive and negative ways. The time it takes to recruit program directors, particularly rotators, has increased significantly in recent years, making it particularly important to prioritize actions NSF can take to strengthen our ability to recruit and retain staff.

   Opportunities for Action or Improvement

   - Develop mechanisms to better manage individual workload and minimize disparities in workload.
   - Implement exit and stay interviews as necessary to identify trends.

Strategic Goal 3: Excel as a Scientific Federal Agency.
Strategic Objective 2: Use effective methods and innovative solutions to achieve excellence in accomplishing the agency's mission.

NSF has determined that this objective should be a focus area for improvement.

The Strategic Review used several sources of evidence to address the key analytical questions, including previous customer satisfaction surveys, evaluation reports, administrative data, a review of customer service performance measures at other agencies (NIH, USDA, NASA, DOE, Education, VA), a panel discussion with the National Science Board, and a small sample of survey responses from program directors and principal investigators (PI) to questions about customer service.

The strategic review team considered the advantages and disadvantages of dwell time versus other metrics of customer service. Three characteristics of customer service were determined to be important: Quality, transparency, and timeliness. The current dwell time goal addresses only timeliness of providing review feedback to the customer. It does not encourage or incentivize other aspects of customer service, such as providing specific post-review feedback to PIs. As part of the Strategic Review, NSF conducted a panel discussion with members of the National Science Board, where members encouraged NSF to consider quality as well as timeliness in our customer service goals. One National Science Board member commented that "speed without quality is not a good standard to have, as one can do a bad job quickly."

The Strategic Review used internal data to assess the impacts on work processes to determine whether the dwell-time goal has unintended consequences on workload or on the review process. The evidence demonstrated that the timing of budget appropriation and current plan implementation does not impact dwell time. However, the dwell time goal encourages staff to process declines before awards because they can be done faster, which creates conflict with award leveling.

The data also show that since 2010 NSF is utilizing fewer total reviewers and fewer new reviewers for more proposals, thereby including less of the community in our review process. This decrease could be due to time limitations to recruit reviewers or the increasing change from ad hoc to panel review. It is difficult to disambiguate the effects of the increasing number of proposals generally as opposed to the specific pressure of a dwell time goal.

The strategic review determined that additional feedback from customers is needed to assess which aspects of customer service should be the targets of a new customer service goal. NSF fielded a survey of NSF PIs and reviewers that included questions about customer service. The forthcoming results of this survey will be used to identify targets for a new customer service goal focused on quality.

Opportunities for Action or Improvement

- Develop and pilot ideas for additional customer service goals based on the results of the customer service survey and analysis of PI behavior.

Status of Actions Recommended in FY 2015 Strategic Reviews

Goal/ Objective	Opportunities for Action or Improvement	Status	Lead Org/s
G1/O1	Develop effective data tracking methods for research involving multiple disciplines.	In FY 2016, the Office of Integrative Activities, Evaluation and Assessment Capability (EAC) office will lead a working group charged with the task of recommending specific mechanisms to improve NSF's ability to track interdisciplinary research. This task will entail developing an operational definition of interdisciplinary research, and an inventory of interdisciplinary activities across NSF. Portfolio analysis tools will be used to confirm or revise the definition. Recommendations will be made based on definitions. In FY 2017, the working group will implement findings and decisions from FY 2016.	OIA/EAC
G1/O2	Initiate a data collection using a common, well-documented methodology across all three graduate support mechanisms.	The NSF-wide Graduate Education Strategic Planning Group will assemble available national data about various modes of support of graduate students by research fields. There are significant data gathered annually on GRFP participants; EAC will review the possibility of gathering similar data on other NSF-funded graduate students. The Graduate Education Strategic Planning Group, in collaboration with EAC and NCSES, will make recommendations about needed national and NSF-specific data collection for consideration by NSF leadership.	EHR OIA/EAC
	Support pilot programs of new concepts in broadening graduate skills. Analyze current approaches that aim to improve graduate student preparedness for entering the workforce beyond traditional roles in academia. Understand how awardee institutions position graduate students for future careers and identify NSF programs that contribute to these types of training activities.	New pilot programs to broaden graduate skills will be part of NSF's Agency Priority Goal to "Improve STEM graduate student preparedness for entering the workforce." A portfolio analysis of proposals submitted to the pilot programs will identify promising approaches and inform the possible scale-up of programs in FY 2017 and beyond. See the Annual Performance Plan for a full description of the Agency Priority Goal.	GEO ENG
	Review the appropriate "package" of support for	These opportunities for action or improvement are under consideration by the	EHR

Goal/ Objective	Opportunities for Action or Improvement	Status	Lead Org/s
	students during their time in graduate school. Explore whether additional investments in fellowships targeting increasing diversity would further the goals of G1/O2.	NSF-wide Graduate Education Strategic Planning Group	
G1/O3	Hold workshops to get community input on funding/ support gaps in NGRI portfolio to accelerate the transition to NGRI.	NSF will add sessions to planned community workshops (as appropriate) to get input on accelerating the transition to NGRI. Focus areas may include better defining NGRI, maximal leverage/sharing of cyber-infrastructure (CI) capabilities, possible funding gaps, restrictive practices, life-cycle management of both existing infrastructure and NGRI, and the important role of human capital. Potential near-term venues include the annual Large Facilities Workshop planned for May 2016 and a separate joint CI/Large Facilities Workshop in FY 2016.	CISE MPS BFA/LFO
	Review NSF policies that affect use or development of NGRI, and issue an appropriate communication to community.	Prior to the 2016 Large Facilities Workshop, NSF will hold a Program Officer's Forum to discuss policies that may be hindering development of NGRI. This input will help inform the community workshop sessions.	CISE MPS BFA/LFO
	Initiate internal discussions to reevaluate whether there are funding gaps that might affect the support of NGRI projects.	NSF is evaluating options for improved facilities portfolio management in order to identify funding opportunities to better support NGRI planning and implementation	BFA/BD BFA/LFO
G2/O1	Refine data management guidance and practices.	NSF will implement, as outlined in publication NSF 15-52, "NSF's Public Access Plan: Today's Data, Tomorrow's Discoveries."	CISE OIRM (CIO)
	Identify and expand partnerships to support creation and sustainability of data management resources.	The Cyberinfrastructure Coordinating and Leadership Group (CLG) has begun to address the issue of sustainability of data management resources. A new activity planned for FY 2017, Data for Scientific Discovery and Action (D4SDA), has goals to stimulate "community engagement to develop governance structures and management of data life cycle and to grow community's use of infrastructure" and to develop "collaborations and partnerships." The CLG will also hold an internal workshop to bring together different parts of the foundation to share information, with the goal of capturing different models for how	CISE (CLG)

Goal/ Objective	Opportunities for Action or Improvement	Status	Lead Org/s
		communities are dealing with sustainability of data resources. The efforts of the CLG will align with NSF's efforts on public access. Additional information can be found in the CIF21 Roadmap.	
	Support a workshop on PPSR learning & broadening participation. Encourage, through existing programs, advances in sensors and communication/ data management infrastructure for PPSR.	This opportunity for action or improvement will be addressed through the Agency Priority Goal on PPSR. Build the capacity of the Nation to solve research challenges and improve learning by investing strategically in citizen science, crowdsourcing, and other forms of public participation in science, technology, engineering, and mathematics (STEM). See the Annual Performance Plan for a full description of the Agency Priority Goal.	EHR CISE
G2/O1	Implement regular exit and stay interviews.	NSF is currently developing exit and engagement (stay) interview templates along with standard operating procedures for their implementation. Pilots are expected to begin in early FY 2016.	OIRM
G3/O1	Develop mechanisms to better manage individual workload and minimize disparities in workload to improve the retention of Program Directors.	NSF is exploring was to combine information contained in what are currently separate business intelligence systems related to personnel and program management in order to enhance the current workload model for transactional activities. In addition, NSF is exploring how to include information on activities going beyond the transaction-based activities of the current model.	OIRM
	In FY 2016 develop ideas for new customer service goals based on the results of the upcoming customer service survey.	PI responses to questions about their satisfaction with the timeliness and quality of feedback received from NSF will be used to develop additional customer service performance goals. Potential performance goals will be assessed internally to determine the effect on Program Officer workload prior to a decision regarding possible implementation in FY 2018.	BFA OIRM
G3/O2	In FY 2016 develop ideas for new customer service goals based on the results of the upcoming customer service survey.	PI responses to questions about their satisfaction with the timeliness and quality of feedback received from NSF will be used to develop additional customer service performance goals. Potential performance goals will be assessed internally to determine the effect on program officer workload prior to a decision regarding possible implementation in FY 2018.	BFA OIRM

Recommendations from FY 2014 Strategic Reviews that were completed in FY 2015

Strategic Goal/Obj.	Action	Status of Proposed Action	Lead Org/s
G1/01	Reinforce NSF commitment to IDR in internal and external communications to ensure that IDR is viewed positively.	A DCL was issued to reinforce NSF's commitment to IDR.	OD/OIA
G1/01	Assess the impact of PTR funding across NSF through formal studies.	An evaluation of the INSPIRE program contracted by the Evaluation and Assessment Capability (EAC) was expanded to include a comparison of mechanism to fund IDR and PTR.	OD/OIA
G1/01	Assess PTR mechanisms, such as EAGERs and Ideas Labs, which have been used for several years, but have not been assessed yet. A formative evaluation for INSPIRE has been initiated.		
G1/01	Institute an external retrospective study that compares the predicted transformative potential (from reviews and panel summaries) of awards and declines from 5-10 years ago with the actual outcomes.		
G1/02	Convene a symposium on "Integration of Research and Education" to synthesize evidence relevant to the proposed theories of change, identify gaps in understanding, and develop a research agenda to determine ways to most effectively develop both a diverse and excellent workforce.	A workshop was held in April of 2015 to explore the multiple interpretations of the phrase "integration of education and research." The Division of Undergraduate Education will use the recommendations to inform future actions.	EHR/DUE GEO

Strategic Goal/Obj.	Action	Status of Proposed Action	Lead Org/s
G1/03	Evaluate the current and future resource and structural needs within the Foundation to successfully support its facilities. The increasing level of complexity of the facility programs that the NSF funds, as well as the recognition that the Foundation is changing the overall planning for the lifecycle of facilities, point to the time being ripe for the Foundation to address this issue.	The Large Facilities Manual (LFM) has been completely revised to include clearer policies and procedures on contingency, cost analysis and management fee. The Large Facilities Working Group (LFWG) has been fully implemented and played a pivotal role in revision of the LFM. The Integrated Project Team (IPT) approach has been implemented on four projects in construction, one in design as a pilot, and one in operations. Both the LFWG and the IPT approach have been codified in the revised LFM. The LFO has also recently added two additional staff to support increased oversight of Large Facilities.	BFA/LFO
G2/01	Study new and emerging IP practices, and disseminate the results in order to stimulate innovative thinking in IP management.	In FY 2015 NSF co-sponsored a national town hall meeting with the University-Industry Demonstration Partnership on February 26, 2015.	ENG
G2/01	Convene a workshop to brainstorm how to further cultivate innovative thinking and entrepreneurship among students (building on NSF I-Corps™ successes), and what new models of education are emerging or will be appropriate. The ultimate goal is to cultivate industry-relevant skills and the mentality for technology commercialization among students.	NSF sponsored the National Innovation Network (NIN) workshop in June 2-3, 2015. The workshop included a review of the training, resource/tool development, and research efforts of the I-Corps™ Nodes and Sites to identify and develop promising ideas that can generate value and enhance the innovation capacity and ecosystem of the Nation.	ENG
G2/02	Develop and implement data collection on impact metrics with respect to NSF-developed communications.	Metrics were identified and are being collected on a quarterly basis.	OLPA
G3/01	Identify indicators of progress for a “diverse, engaged, and high performing” workforce and the data sources for establishing baselines and measuring progress.	Indicators were identified and baselines established.	OIRM/HRM

Strategic Goal/Obj.	Action	Status of Proposed Action	Lead Org/s
G3/01	Structure the developing human capital dashboard to make data and information on key indicators accessible to decision makers at a glance and enable deep dives for targeted action.	The first phase of Strategic Human Capital Management (SHCM) Dashboard has been completed; focus areas include retention and loss rates, career paths and development opportunities, hiring patterns and time to hire, and workload; indicators include a combination of workforce profile data from HR systems and data from the Federal Employee Viewpoint Survey (FEVS); Dashboard is now being expanded from a few basic indicators to a broader knowledge system.	OIRM/HRM
G3/01	Use short "pulse" surveys, focus groups, and other mechanisms to understand what it will take to retain at least 70 percent of NSF's current permanent staff through the transition to Alexandria. Prioritize actions and strategies based on the result.	A number of outreach activities identified strategies focused on workforce planning, recruitment, hiring and retention, action planning for employee engagement, diversity and inclusion, and improvements to performance management systems. The FY 2015 Strategic Review for this objective focused on Program Officer recruitment and retention as a follow-up.	OIRM/HRM
G3/01	Create explicit strategies to replace both the rotator population and retirements anticipated between now and 2016.		

Recommendations from FY 2014 Strategic Reviews that are expected to be completed in FY 2016

Strategic Goal/Obj	Action	Lead Org/s
G1/01	Modify NSF e-business systems and processes to allow for IDR complexity.	OD/OIA CPIC OIRM/DIS
G2/02	Assess the quality of the proposal responses to the revised elements of the broader impacts criterion.	OD/OIA
G2/02	Consider strategies to facilitate coordinated broader impacts efforts above the project level.	EHR(IUSE working group)
G3/01	Create the underlying logic models for how strategies related to recruitment, training, leadership, and human capital management influence building an increasingly diverse, engaged, and high performing workforce, with particular attention to inter-dependencies of strategies and outcomes.	OIRM/HRM
G3/02	Implement a cultural assessment, using evidence-based survey tools, with the goal of identifying our organizational strengths and opportunities for improvement. The results of the cultural assessment will be reviewed in the context of the results of the Federal Employee Viewpoint Survey to describe actionable objectives towards agency excellence.	SBE BFA OIRM