

FY 2020 NSF STRATEGIC OBJECTIVE PROGRESS UPDATES

In FY 2020, the National Science Foundation conducted Strategic Reviews (SRs) of the six Strategic Objectives in its 2018-2022 Strategic Plan in response to the requirement of the GPRA Modernization Act 2010 Section 1116(f). Table 1 summarizes the outcomes to date of each SR. The table also provides NSF's determination as to whether performance towards an Objective is making noteworthy progress, should pursue focused improvement, or neither.

Two Components to NSF SRs: Topic Reviews and Objective Rankings

NSF's Strategic Review Process uses the results of existing assessments, evaluations, and reports as well as other sources of evidence. Dashboards for each of the Strategic Objectives in the NSF Strategic Plan are updated. These Objectives are crosscutting and do not mirror NSF's organizational structure, and the major strategic issues often facing NSF seldom fit within a single Objective, so NSF also scans the environment for topics and conducts crosscutting topical Reviews as necessary. These are performed as a cross-Foundational activity, without concentrating on single organizational units or individual programs.

Both elements of the process draw upon comprehensive assessment processes that already are in use at NSF. For example, the annual Merit Review Report to the National Science Board¹ describes all annual outputs. The Committees of Visitors (COV) process², in which external experts assess NSF programmatic activities approximately every four years, is also comprehensive. Instead of duplicating these efforts, the strategic review process at NSF complements them by making use of the information they generate when appropriate (e.g. reviewing their recommendations or using their data in a topic review, and using them as sources of evidence for a dashboard).

FY 2020 Objective Rankings

For the Objective rankings, NSF's Performance Improvement Officer (PIO) reviewed internal performance dashboards which contain information on relevant measures, recent evaluative activities, challenges, and risks in each Objective's domain. The Objectives ranked "Noteworthy Progress" are:

- 1.1, Knowledge: Advance knowledge through investments in ideas, people, and infrastructure.
- 3.1 Human Capital: Attract, retain, and empower a talented and diverse workforce.

These rankings reflect strides made in two areas. The first is workforce management, both overall and particularly in the development of the workforce that oversees research infrastructure, including mid-scale projects and major facilities. This progress contributes to both agency objectives. The second area rated as achieving noteworthy progress is large facilities governance, another area supported by multiple objectives, and here considered as also contributing to the ranking of 1.1.

The Objective ranked "Focus Area for Improvement" is 3.2, Processes and Operations: Continually improve agency operations. This ranking reflects the need to establish and maintain an appropriate balance of funding across NSF for programmatic, operational, and support activities. A thoughtful balance is needed to ensure the agency can accommodate the additional responsibilities associated with the Administration's priorities in research and education. This will ensure that its ongoing efforts to be agile, adaptable, and able to work at speed and scale remain robust as it moves forward in the post-pandemic environment.

2020 Process Adjustments

NSF's FY 2020 SR process was already underway in early March when normal operations were interrupted by the COVID-19 pandemic. Despite the challenges that the pandemic presented, NSF's SR teams were able to continue their work as planned with only minor delays. Thanks in large part to the IT infrastructure and flexibilities afforded by NSF to all staff, the SR teams' work and their reports to leadership were able to proceed in a fully remote setting.

Topical Review of “Stewardship Model” of Funding

Strategic Objective 1.1: Knowledge: Advance knowledge through investments in ideas, people, and infrastructure.

Strategic Objective 1.2: Practice: Advance the practice of research.

Strategic Objective 2.1: Societal Impacts: Support research and promote partnerships to accelerate innovation and to provide new capabilities to meet pressing societal needs.

Strategic Objective 3.2: Processes and Operations: Continually improve agency operations.

Background and Key Analytical Questions

In 2019, NSF launched ten “Big Ideas” to identify and support emerging opportunities for U.S. leadership in Big Ideas that serve the Nation's future. Each initiative involved multiple NSF directorates/offices. Through an innovative pilot funding approach – the “Stewardship Model” – funds for each of the Big Ideas were held within one directorate, while management was carried out by a steering committee composed of senior managers in collaboration with working groups from all participating directorates/offices. The main idea was that, by holding the funds in one place, decisions to fund the best research would be less conflicted by the disciplinary interests of the individual directorates/offices participating in a funding research initiative.

The Review of the Stewardship Model addressed the following two hypotheses:

1. The Stewardship Model funding decisions focus on identifying the best scientific research, regardless of field/discipline. There is less focus on ensuring that the award portfolio reflects the funding contributed by different NSF directorates.
2. The Stewardship Model more effectively promotes collaboration in the funded research activities.

From these two hypotheses, three Key Analytical Questions (KAQs) were developed:

- **OUTCOME**: How does the Stewardship Model compare to other funding models, in terms of merit review process outcomes/outputs?
- **PROCESS**: Does the Stewardship Model alter the way funding decisions are made?
- **BEST PRACTICES**: What best practices can we identify, and what lessons have we learned, from the way the research Big Ideas implemented the Stewardship Model?

Evidence and Conclusions

A set of programs were selected to compare and analyze in response to the KAQs. Besides the six research Big Ideas, a comparator group of cross-directorate programs were chosen for their similarity in interdisciplinarity, partnerships, and timeframe to the Big Ideas and their manageability in scope and measurement. All the programs were evaluated via both quantitative and qualitative approaches to address the KAQs. The results from these analyses were integrated into a final set of conclusions and recommendations.

To gather perspectives from NSF staff involved in the research Big Ideas programs and other similar cross-directorate programs, a survey was designed and distributed; responses were collected from the various directorates/offices across NSF. Individual interviews were also conducted with Steering Committee and Working Group Chairs, program officers, administrative staff, and a focus group of budget officers. Everyone interviewed had direct experience with the Big Ideas programs/ stewardship model and several had experience with programs in both the Big Ideas and the comparator programs or other cross-directorate programs. Additional data was compiled and analyzed from NSF business systems, including proposal and award data, reviewer data, panel data, and management plans, to examine measures such as funding rates, panel composition, panel management, dwell time, award splits, proposal and award management, and award interdisciplinarity.

Performance and Management

Most measures examined found no significant difference between the stewarded programs and the comparator programs and determined that existing differences were driven more by the management of the individual programs rather than the funding model used. Three major conclusions from this SR's analyses are:

1. NSF has been successful at fostering collaboration utilizing different funding models.
2. There were advantages to allowing flexibility in the management and implementation of the stewardship model of funding.
3. A range of issues were revealed during the implementation of the stewardship model (cultural, business systems, fiscal year timing, scale of effort, NSF capacity).

Opportunities for Action or Improvement

The team made the following three recommendations:

1. Continue to utilize multiple models for funding the best research.
2. Develop a decision tree to determine the best management model to use for a given research area and approach.
3. Ensure that each model can be effectively implemented.

Activities after the SR

In response to the Strategic Review findings and recommendations, NSF created a Working Group (WG) to develop a decision support tool. The WG developed a "decision tool" that frames funding options as a continuum between the most and least centralized approaches, and therefore aims to help decision-makers assess the potential fit of different funding approaches and become better aware of the trade-offs associated with the different options. The tool was tested with stakeholders and a pilot-ready draft was presented to leadership in spring 2021. In summer and fall, the tool is being piloted and further refined. After gathering feedback, NSF will determine the best ways to deploy the tool and ensure its use going forward.

Topical Review of NSF’s Major Research Infrastructure Portfolio

Strategic Objective 1.1: Knowledge: Advance knowledge through investments in ideas, people, and infrastructure.

Strategic Objective 1.2: Practice: Advance the practice of research.

Strategic Objective 3.2: Processes and Operations: Continually improve agency operations.

Background

This Review focused on NSF’s processes for the entry of projects into the Development and Design Stages, as defined in Sections 2.2 and 2.3 of the Major Facilities Guide (MFG). The National Science Foundation (NSF) invests in all disciplines of basic research, including the necessary supporting research infrastructure. NSF’s portfolio of major facilities represents a substantial fraction of its total budget, including construction and operations of facilities at sites throughout the U.S. and around the world. Oversight of activities related to these facilities is led by Program Officers in distinct Directorates, in close collaboration with multiple Divisions within the Office of Budget, Finance, and Award Management (BFA).

Projects in the Development Stage are typically managed solely at the Program level, normally as discrete awards for prototyping or research and development to advance technologies or methods that could eventually lead to the full implementation of larger projects. As a result, entrance in and advancement through the Development Stage has been informal and therefore not always visible to NSF Leadership, including the National Science Board.

In addition, because of the lack of clear communication pathways for sharing information about projects in the Development Stage and the lack of guidelines for entrance in the Design Stage at points beyond Conceptual Design, there is the appearance of a dearth of future projects seeking funding from the Major Research Equipment and Facilities Construction (MREFC) account. Furthermore, NSF’s implementation of the Mid-scale Research Infrastructure (Mid-scale RI) Track 1 and Track 2 programs (the latter being funded under the MREFC account) has created an important and growing category of NSF-supported research infrastructure. Some mid-scale activities may eventually scale to larger facility projects. In such cases, a pathway to incorporate them into the broader Development and Design Stage strategies should be considered.

Key Analytical Questions

- **PROCESS:** What are the characteristics of the many paths through development and design that have been used?
- **STRATEGY AND PLANNING:** What does NSF need to consider when improving the MREFC-funded research infrastructure's Development and Design Stages?

Evidence and Conclusions

The Review team sought evidence to understand the nature of the problem described above in three ways: analysis of two decades of records from NSF annual budget submissions, consideration of case studies describing the path through development to MREFC funding for a variety of large facility projects, and review of the outcomes of the first round of Mid-scale Research Infrastructure solicitations.

The budget information illustrated both the steady progress of some facilities from “horizon projects” through candidate MREFC status and the occasional disappearance of “horizon projects” from one year to the next (usually due to programmatic decisions, although with little or no documented explanation).

Descriptive case studies of the development of major facility projects across several of the disciplines supported by NSF revealed an array of pathways from genesis of an idea to entry into the MREFC-funded “queue.” A nearly universal finding was that the Development Stage for successful projects is long,

typically one to two decades from the first clear indication of the need for the infrastructure to formal entry into the Design Stage for Major Facility projects.

Another clear takeaway from the case studies was that there is no uniform pathway or process for identifying an idea, nurturing its development, and advancing it to a level of readiness for entry into the MREFC Design process. The surfacing of ideas for development of new research infrastructure (RI), and the process for prioritizing among them, varies across disciplines. This diversity of development pathways represents both a necessity and a strength, given the breadth of disciplines supported by NSF and the different cultures of the various communities.

Opportunities for Action or Improvement

The team made the following four recommendations:

1. Collect consistent information (at least annually) from all Divisions on projects in development.
2. Clarify, and possibly expand, mid-scale and MREFC-scale development and design funding opportunities and scope.
3. Broaden access to BFA expertise, both internally (PO training & project evaluation) and externally (community workshops and capacity building).
4. Define in the Major Facilities Guide the process for evaluating “readiness” for project entry into the MREFC Design Stages beyond Conceptual Design.

Activities after the SR

In response to the Strategic Review findings and recommendations, NSF has taken the following steps:

- Per recommendation 1: A list of development-stage projects is currently being developed.
- Per recommendation 2: Both MSRI solicitations have been updated to reflect the recommendation.
- Per recommendation 3: BFA has added a staff person for a new position dedicated to internal and external outreach to broaden access to BFA expertise on large facility projects.
- Per recommendation 4: The Major Facilities Guide is in the process of being updated, and the new version is expected to be available in September 2021.