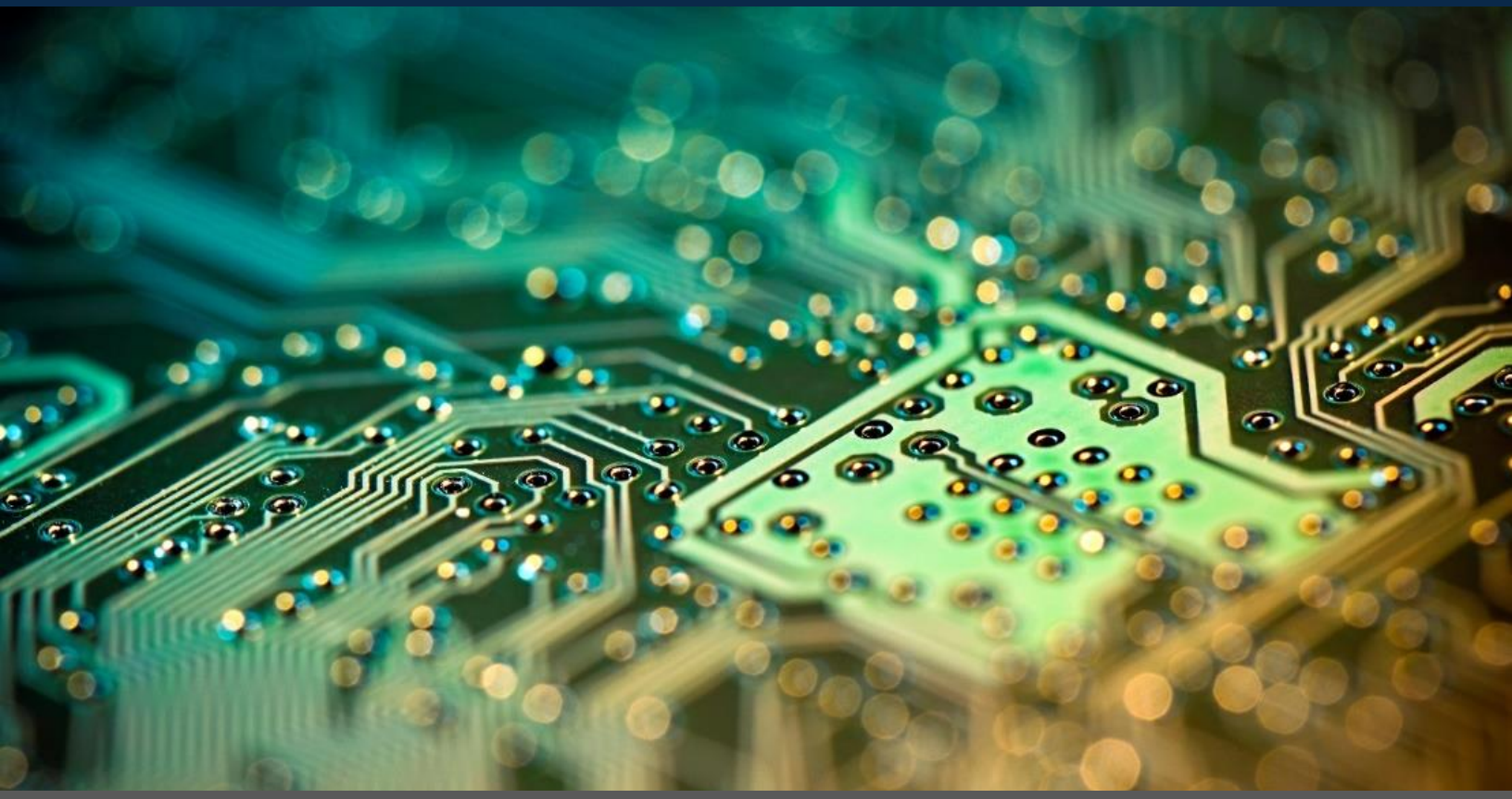
A Report by a Panel of the

NATIONAL ACADEMY OF PUBLIC ADMINISTRATION

for the National Science Foundation

Assessing the Conditions for the Successful Establishment of the NSF's Directorate for Technology, Innovation and Partnerships



NATIONAL ACADEMY OF PUBLIC ADMINISTRATION®

November 2023

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Assessing the Conditions for the Successful Establishment of the NSF's Directorate for Technology, Innovation and Partnerships

PANEL OF ACADEMY FELLOWS

Barry Bozeman,* *Chair*

Nick Hart*

Randolph Lyon*

Theresa Pardo*

Janet Weiss*

**Academy Fellow*

Study Team

Brenna Isman, *Director of Academy Studies*

Jonathan Tucker, *Project Director*

Mark Hertko, *Deputy Project Director*

Robert Goldenkoff, *Senior Advisor*

Chloe Yang, *Senior Research Analyst*

Sarah Jacobo, *Research Associate*

Nadia Faour, *Research Associate*

*Academy Fellow

The views expressed in this report are those of the Panel. They do not necessarily reflect the views of the Academy as an institution.

National Academy of Public Administration

1600 K Street, NW
Suite 400
Washington, D.C. 20006
www.napawash.org

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Foreword

The National Science Foundation (NSF) is an independent federal agency established in 1950 by Congress "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…." NSF supports research and the fields of fundamental science and engineering, except for medical sciences, and helps the United States drive leading discoveries.

In March 2022, NSF established the Directorate for Technology, Innovation and Partnerships (TIP). Enhancing the mission of NSF, TIP seeks "to advance use inspired and translational research, powering innovative technologies, addressing the foremost challenges of our time like climate change, and critical and resilient infrastructure, and nurturing an equitable workforce for future, high-wage, quality jobs." TIP was established to focus on significant challenges and opportunities across the entire science and engineering enterprise and to strengthen and scale critical research, innovation, and translation that will drive future technologies and solutions.

As a congressionally chartered, independent, non-partisan, and non-profit organization with over 1,000 distinguished Fellows, the Academy has a unique ability to bring nationally recognized public administration experts together to help government agencies address challenges. This assessment by a five-member Panel of Academy Fellows provides recommendations that can further advance the vital mission of the NSF through its creation of the Directorate for Technology, Innovation and Partnerships. I am deeply appreciative of the work of the Panel and commend the Study Team that contributed valuable insights and expertise throughout the project. I am also grateful for the constructive engagement of the many NSF employees and external stakeholders who provided their time to provide important observations and context to inform this work.

Teresa W. Gerton
President and Chief Executive Officer
National Academy of Public Administration

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Acronyms and Abbreviations

Acronym or Abbreviation	Definition
Academy	National Academy of Public Administration
AOAM	Agency Operations and Award Management
BAA	Broad Agency Announcement
BFA	Office of Budget, Finance and Award Management
BIO	Directorate for Biological Sciences
CHIPS	CHIPS and Science Act of 2022
Commerce	Department of Commerce
EDU	Directorate for STEM Education
NSF Engines	Regional Innovation Engines
FTE	Full Time Equivalent
HR	Human Resources
IHE	Institute of Higher Education
IPA	Intergovernmental Personnel Act assignee
MREFC	Major Research Equipment and Facilities Construction
MOU	Memorandum of Understanding
NSB	National Science Board
NSF	National Science Foundation
OGC	Office of General Counsel

OTA	Other Transaction Authority
PD	Program Director
SBIR	Small Business Innovation Research program
R&RA	Research and Related Activities
R&D	Research and Development
SPH	Strategic Partnerships Hub
STEM	Science, Technology, Engineering, and Math
STTR	Small Business Technology Transfer program
TIP	Directorate for Technology, Innovation and Partnerships

Executive Summary

The National Science Foundation (NSF) supports basic research in all fields of science and engineering, except for medical sciences. In 2022, Federal agencies such as the Department of Defense and Department of Health and Human Services accounted for 67 percent of federal support for research and development (R&D), which is focused on their particular agency missions.[1] By contrast, NSF is responsible for supporting the general health of the basic research enterprise, including funding infrastructure and scientific workforce development.

The core mission focus of NSF since its inception has been on supporting curiosity-driven, basic research ideas articulated and prioritized by university-based academics. Support for basic research was largely determined through a process whereby recognized experts in a given research field set priorities and identified the best scientific proposals based on accepted disciplinary standards.

Over time, NSF has been called upon to expand the translation-work focus of its mission. Most recently, the rise in international, technology-related competition and associated national security concerns stimulated a rethinking of America's approach to supporting science and technology. This contributed in part to the enactment of the CHIPS and Science Act of 2022 (CHIPS). CHIPS embodies two different but overlapping sets of objectives, including accelerating key technologies and addressing national, societal, and geostrategic challenges, all through greater attention to use-inspired and translational research. Another key focus for CHIPS is harnessing the geography and demography of innovation that exists throughout the United States across the research life cycle.

As part of the above vision, CHIPS authorized the establishment of the new NSF Directorate of Technology, Innovation and Partnerships (TIP) to take the lead in carrying out the expanded focus on use-inspired and translational research, along with increased levels of funding. However, Congress recognized that TIP could not implement the expanded mission efforts in isolation. This realization is reflected in the mandate for an independent report by the National Academy of Public Administration (the Academy). The mandate includes the requirement that the report "determine current plans for engaging with other directorates and offices of the NSF, and with other Federal agencies." TIP is intended to leverage the capabilities of the broader NSF and federal government science and technology enterprise, as well as tap the resources and capabilities of other external stakeholders, including industry and nonprofits, as needed to accomplish its expanded mission. At the time of this publication, the TIP Directorate is less than two years old and continues to develop as it stands up operations.

The successful implementation of NSF's expanded mission focus will require not only sufficient funding, but also staff members with different backgrounds and skills. Most notably, the greater emphasis on collaboration across NSF directorates with other federal agencies and an expanded range of external stakeholders places a premium on background and skills related to identifying,

[1] Congressional Research Service, *Federal Research and Development (R&D) Funding: FY2023,* June 2022, https://crsreports.congress.gov/product/pdf/R/R47161#:~:text=In%20FY2022%2C%20six%20agencies%20received,of%20all%20federal%20R%26D%20funding.

developing, and sustaining collaborations. Collaboration is not new to NSF, but the scale, diversity and importance of collaboration has increased with the expanded mission mandate.

Successful implementation will also require substantive changes in some cases to NSF processes and procedures to enable new approaches to accomplish the expanded mission, such as the use of new tools authorized by CHIPS. Human resources, information technology, and other mission support functions will need to be adjusted or establish new processes to ensure that NSF is able to successfully integrate TIP into the Agency. TIP officials are working collaboratively with NSF-level mission support offices to accomplish needed changes.

More generally, TIP leaders have been experimenting with new approaches to accomplish the expanded mission of NSF, such as reaching out to a broader set of stakeholder communities for proposals, adding a varied set of criteria for submitting proposals, engaging more diverse sets of experts for peer review of proposals, and encouraging more extensive and different kinds of collaboration across directorates and programs and with external stakeholders.

TIP, in collaboration with other directorate- and NSF-level officials, will need to take steps to ensure that new approaches are properly assessed, and effective practices are identified and built into the normal operation of NSF through institutionalization. In short, a sustained change management process will be needed for the expanded mission to succeed. This includes top leaders' sustained support, a clear vision and implementation plan, effective communication, and the development of policies and procedures, training, and mechanisms for accountability. To this end, this report includes a review of good practice guidance on change management.

Based on the assessment conducted by the Academy, the Panel makes the following recommendations:

1. TIP should establish a formal, integrated strategic management process that clearly produces the directorate's priorities, strategic goals, objectives, strategies, and performance metrics.

2. TIP leaders should develop a strategic workforce planning process to regularly determine if they have the (1) number of staff needed to support the directorate's workload, and (2) staff members with the correct skill sets to support the nature of their work. TIP leaders should develop their workforce strategy based on their ongoing discussions with NSF leaders and mission support.

3. Senior leaders of NSF and TIP should jointly develop an implementation plan for the Strategic Partnerships Hub (SPH) that prioritizes the Hub's responsibilities and resource needs for continued development and growth.

4. TIP leaders should work collaboratively with NSF and mission support leaders to develop a plan that identifies and prioritizes mission support resource opportunities and challenges that must be addressed to enable the successful performance of NSF's expanded mission focus.

5. TIP leaders should work with the leaders of other NSF directorates to identify ways to reward collaboration across directorates on mission-critical activities through the

individual performance plans of responsible officials. Also, TIP should continue its practice of setting aside funds for joint programs and funding opportunities.

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Chapter 1: Introduction

The National Science Foundation (NSF), which includes the National Science Board (NSB), is an independent federal agency established in 1950 by Congress "to promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense; and for other purposes."[2] NSF supports basic research and the fields of fundamental science and engineering, except for medical sciences, and helps the United States drive leading discoveries. These efforts span from fundamental scientific inquiry to use-inspired basic research leading to innovation and translation.

NSF research strives to be at the frontier of science and help society. In 2022, Federal agencies such as the Department of Defense and Department of Health and Human Services accounted for 67 percent of federal support for research and experimental development (R&D).[3] This research is focused on the particular missions of these agencies. By contrast, NSF is responsible for supporting the basic research enterprise more generally. NSF sponsors research across the full range of science and engineering disciplines, and it seeks to support the general health of the basic research enterprise, including funding infrastructure and scientific workforce development.

One focus of NSF since its inception has been on supporting curiosity-driven, basic research ideas articulated and prioritized by university-based academics. Support for basic research was largely determined through a process whereby recognized experts in a given research field set priorities and identified the best scientific proposals based on accepted disciplinary standards. This general approach was modified during the 1980s in response to the rise of foreign industrial competition. The competitive challenge was seen partly in terms of the United States' ability to translate research results more efficiently and effectively into commercially viable technologies, and led to multiple government initiatives.

The 1980s was a period of innovation in governmental approaches to science and technology, with multiple changes in law and policy being implemented. In the case of NSF, Congress authorized the creation of the Directorate of Engineering.[4] A major aim of the new directorate was to engage potential industrial and other users more directly in the processes of agenda setting and participation in research programs. In addition, several new programs with elements of research partnerships, workforce development, economic and commercial development, translation, and broadening research capacity were established. Notable NSF programs include the following: the Engineering Research Centers (1985) promoting convergent research, education, and technology

[2] The National Science Foundation Act of 1950 (P.L. 81-507), https://www.nsf.gov/about/history/legislation.pdf.

[3] Congressional Research Service, *Federal Research and Development (R&D) Funding: FY2023*, June 2022, https://crsreports.congress.gov/product/pdf/R/R47161#:~:text=In%20FY2022%2C%20six%20agencies%20received,of%20all%20federal%20R%26D%20funding. In 2017, OMB adopted a refinement to the categories of R&D, replacing "development" with "experimental development," which more narrowly defines the set of activities to be included. This is inclusive of NSF's definitions of Research and Development, Basic Research, Applied Research and Development (or Experimental Development).

[4] "Chapter V: New Concerns; New Opportunities, 1977-1985," The National Science Foundation: A Brief History, National Science Foundation, published July 15, 1994, https://www.nsf.gov/about/history/nsf50/nsf8816.jsp#chapter5. 1979 Engineering Division elevated to Engineering Directorate. 1981 changed to Science and Engineering Education Directorate.

translation; the Science and Technology Centers (1987) promoting research through partnerships among academic institutions, national laboratories, industrial organizations and other entities, both domestically and internationally; the Small Business Innovation Research (SBIR) program (1982),[5] supporting domestic small businesses engagement in R&D with the potential for commercialization; and the Established Program to Stimulate Competitive Research (EPSCoR) program (1978 & 1988) building capacity for research, education, and economic development beyond the project at academic, government, and private sector levels.[6] These programs helped revolutionize the structure of the university research enterprise.

The economic rise of China and related competitive and national security concerns stimulated another rethinking of America's approach to supporting science and technology. This rethinking may be understood in terms of two streams reflected in the new Directorate for Technology, Innovation and Partnerships (TIP) established by the CHIPS and Science Act of 2022 (CHIPS). TIP places greater emphasis on use-inspired research and translation.

The Senate and House of Representatives authorizing committees each had a vision for CHIPS which was substantially overlapping, with some divergence. For example, the Senate's authorizers' unique perspective focused on competitiveness and national security concerns posed by China related to the production of emerging technologies. The Senate proposed developing domestic regional economies to meet the challenge, while the House of Representatives authorizers focused on capacity building and equity in participation and outcomes of NSF's scientific enterprise as a means to achieve greater emphasis on translation of research results into outcomes.

In March 2022, prior to the enactment of CHIPS in August 2022, NSF established the TIP Directorate, the first new NSF directorate in over thirty years. Building on the mission of NSF, TIP seeks "to advance use-inspired and translational research, powering innovative technologies, addressing the foremost challenges of our time like climate change, and critical and resilient infrastructure, and nurturing an equitable workforce for future, high-wage, quality jobs."[7] TIP was created to focus on challenges and opportunities across the entire science and engineering enterprise and to strengthen and scale the critical research that will drive future technologies and solutions. TIP has three primary focus areas, namely, "fostering innovation ecosystems, establishing translation pathways, and partnering across sectors to engage the nation's diverse talent."[8] At the time of this publication, the TIP directorate is less than two years old and continues to develop as it stands up operations.

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[5] Eleven federal organizations, including NSF, have established SBIR programs. Each SBIR program operates independently, and its structure is influenced by its parent organization.

[6] See Congressional Research Service, *Established Program to Stimulate Competitive Research (EPSCoR): Background and Selected Issues,* updated January 12, 2017, https://crsreports.congress.gov/product/details?prodcode=R44689.EPSCoR was first established by resolution in 1978 by NSF's governing board and was formally established in statute in 1988.

[7] "Technology, Innovation and Partnerships FAQ's," National Science foundation, updated March 2022, https://nsf-gov-resources.nsf.gov/2022-03/FAQs%20Factsheet%20TIP%20revise%20march%202022%20v4.pdf.

[8] "NSF, EDA announce official coordination on regional innovation programs," National Science Foundation, published July 26, 2023, https://new.nsf.gov/tip/updates/nsf-eda-announce-official-coordination-regional.

Study Scope

In addition to authorizing the TIP Directorate, CHIPS directed the NSF Director to contract with the National Academy of Public Administration (the Academy) "to evaluate and make recommendations to efficiently and effectively implement the Directorate for Technology, Innovation, and Partnerships; and, evaluate and make recommendations to ensure coordination of the Directorate for Technology, Innovation, and Partnerships with other directorates and offices of the Foundation and other Federal agencies."[9]

The study has two main tasks:

Objective 1 – Evaluate and make recommendations to implement the TIP Directorate efficiently and effectively. Specific activities leading to the recommendations shall consist of the following:

- Identification of gaps in institutional practices, policies, and structures, related to TIP performing its mission and mission-support functions;
- Identification of resources needed to support TIP in its mission delivery; and
- Identification of opportunities for eliminating areas of unnecessary duplication, reducing waste, and improving efficiency.

Objective 2 – Evaluate and make recommendations to ensure coordination of the TIP Directorate with other NSF directorates and offices and other Federal agencies. Specific activities leading to the recommendations shall consist of the following:

- Determine current plans for engaging with other directorates and offices of the NSF, and with other Federal agencies; and
- Make recommendations to effectively pursue the above-referenced coordination.

Study Approach and Methodology

The Academy assembled a five-member Panel of Academy Fellows to direct and oversee the study. The Panel includes experts who have extensive expertise and experience in the areas of program implementation and evaluation, innovation studies, change management, and federal government R&D funding programs. Panel member biographies are provided in Appendix A. The Panel conducted three meetings to review the research progress and provide input and direction. The Panel approved the research findings, observations, and recommendations in this report.

The Study Team engaged in both primary and secondary research to develop findings and recommendations for consideration by the Panel. As background research, the Study Team conducted an extensive review of relevant documents and reports, including documents relating to NSF's and TIP's mission and history, budgets, staffing, strategic planning, and performance plans. The Study Team developed two data collection instruments to obtain the views of TIP leaders on the extent to which TIP is implementing leading practices related to partnerships and program management (i.e., strategic planning and organizational alignment, strategic human capital management, and organizational transformation and change management). Leading

[9] CHIPS and Science Act of 2022, Pub. L. No. 117-167, 136 Stat. 1366 (2022), https://www.congress.gov/117/plaws/publ167/PLAW-117publ167.pdf.

practices were identified based on a review of reports and other documents issued by GAO and OMB. After receiving responses, the Study Team had follow-up meetings with TIP officials to discuss their responses, obtain additional elaboration and context, and develop a more thorough understanding of the key issues, opportunities, and challenges.

In addition, the Study Team gathered information through semi-structured interviews with more than sixty individuals, including TIP's senior leaders and staff, senior NSF officials, congressional staff, officials from other federal agencies, and other stakeholders and experts. All interviews were conducted on a not-for-attribution basis. Appendix B provides a comprehensive list of the individuals interviewed by the Study Team.

The Study Team also conducted an online survey distributed to all (ten at the time of the survey) of TIP's direct partners to gain a broad set of perspectives on the effectiveness of TIP's partnership efforts. While the survey response rate (50 percent) was lower than anticipated,[10] responses received were consistent with the major themes that emerged from the interviews the Study Team had with relevant stakeholders.

Organization of the Report

The report presents the Panel's key findings and recommendations derived from interviews and document reviews. The report is organized as follows:

Chapter 1: Introduction

Chapter 2: Background

Chapter 3: TIP's New Approaches for Mission Delivery

Chapter 4: Challenges to Achieving and Sustaining TIP's Mission

[10] The Study Team sent the survey to 10 organizations that have formal signed agreements (usually a memorandum of understanding [MOU]) with TIP.

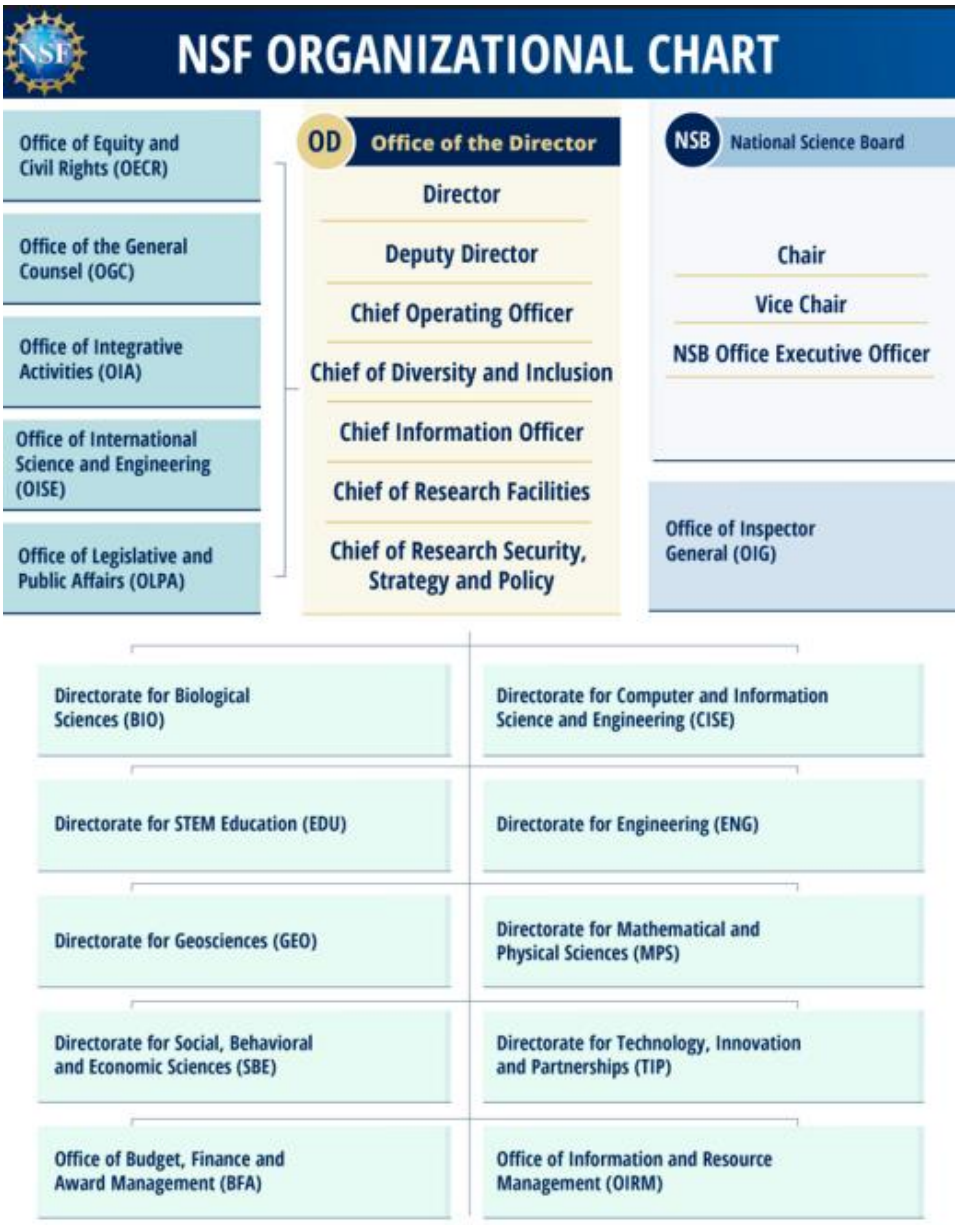
Chapter 2: Background

The CHIPS and Science Act of 2022 (CHIPS) authorized a substantial expansion of NSF's mission and corresponding funding to support it. This chapter focuses on some fundamental features of NSF's organization, funding, and staffing that are important to understand the implications of CHIPS.

Organization of NSF

To enable the execution of this expanded mission, CHIPS authorized the establishment of the Directorate for Technology, Innovation and Partnerships (TIP), the first new directorate in NSF since the 1980s. TIP is one of eight NSF directorates that are primarily responsible for carrying out the mission activities of NSF. Six directorates – Biological Sciences; Computer and Information Science and Engineering; Engineering; Geosciences; Mathematical and Physical Sciences; and the Social, Behavioral and Economic Sciences – are directly responsible for supporting their respective research communities within natural science, engineering, and social sciences. Another directorate, the STEM Education (EDU) Directorate, has cross-cutting responsibilities for supporting science, technology, engineering, and math (STEM) education. The eighth directorate is the TIP Directorate which has a cross-cutting mission to pursue scientific innovation through supporting use-inspired research, translation, and workforce development. These directorates and the other offices responsible for providing mission support are represented in Figure 1.

Figure 1. NSF Organizational Chart



Source: President's FY2024 Budget Request

Funding of NSF

CHIPS authorized a doubling of NSF's budget over five years, potentially boosting its capacity to fund research, translation, and STEM initiatives. However, authorization levels do not always translate directly into appropriations. This section aims to briefly explain how the authorizations and appropriations are translated into funding for NSF and TIP.

NSF's budget request and congressional appropriations are organized around the following six categories.

1. Research and Related Activities (R&RA) – funds areas responsible for carrying out NSF's mission activities, including directorates and program offices, and part of the information technology (IT) functions to support mission activities.
2. STEM Education (EDU) Directorate – EDU is the only directorate with a line-item appropriation in NSF and the funding supports a range of activities related to education and workforce development.
3. Major Research Equipment and Facilities Construction (MREFC) – funds the development and oversight of major research facilities.
4. Agency Operations and Award Management (AOAM) – funds salaries and expenses related to NSF's permanent federal employees, and part of the IT functions that support NSF's administrative and operations capabilities.
5. National Science Board (NSB) – funds NSB's staffing and operations.
6. Office of Inspector General (OIG) – funds OIG's staffing and operations.

CHIPS authorized increased funding for NSF and the creation of the new TIP Directorate. The authorized levels for fiscal year 2023 through fiscal year 2027 are presented in Table 1.

Table 1. NSF CHIPS and Science Act Authorizations for FY2023-27 (Dollars in Millions)[11]

	FY23	FY24	FY25	FY26	FY27
R&RA	$9,050.00	$12,050.00	$12,850.00	$13,800.00	$14,700.00
TIP	*1,500.00*	*3,350.00*	*3,550.00*	*3,800.00*	*4,100.00*
EDU	1,9500.00	2,500.00	2,700.00	2,850.00	3,000.00
MREFC	249.00	355.00	370.00	372.00	375.00
AOAM	620.00	710.00	750.00	770.00	800.00
NSB	5.09	5.32	5.56	5.81	6.07
OIG	23.39	26.61	31.11	34.61	38.11
NSF Total	$11,897.48	$15,646.93	$16,706.67	$17,832.42	$18,919.18

Source: CHIPS and Science Act of 2022

As noted above, EDU is the only directorate that has a line-item appropriation. Otherwise, appropriations for the directorates are made to the R&RA account. The allocation of the R&RA account's appropriations to the seven directorates and NSF program offices is left to the discretion of NSF leaders. Funding for TIP and other directorates is decided through an agency-level allocation process with input from OMB during the annual budget development process.

[11] TIP's authorized funding is factored into the total authorizations for R&RA because Congress wanted TIP to be funded through the R&RA account like the other six basic research directorates.

Table 2. TIP Budget FY2022-24 (Dollars in Millions)

	FY22	FY23	FY24
Authorized	N/A	$1,500	$3,350
Budget Request	$864.87	$879.87	$1,185.63
NSF Allocation from Appropriations	$413.09	$880.00	TBD

Source: President's FY2022-24 Budget Requests

NSF established TIP in March 2022, a few months before the authorizing legislation was enacted in August 2022. The President's Budget for FY22 included a request for the TIP Directorate. The request focused on funding existing programs moved to TIP, establishing some programs later described in CHIPS, and standing up the directorate's divisions and partnerships hub.[12] For FY22, the President's Budget requested $864.87 million for the TIP Directorate and TIP received $413.09 million.

In fiscal year 2023, TIP was authorized $1.5 billion for its first year; however, $879.87 million was requested. For FY23, NSF allocated $880 million from its appropriations to TIP, making TIP the only directorate that matched the budget request for that year. The allocation includes $430 million from a Disaster Relief Supplemental appropriation to NSF.

The gap between the budget request and authorizations for TIP continues to grow in the FY24 budget request. The President's Budget requested approximately $1.186 billion for TIP, while the authorization for FY24 is $3.35 billion. Additionally, the budget requested for R&RA ($9.018 billion) is almost $3 billion short of the authorized amount ($12.05 billion). The FY24 budget may be further limited by the Fiscal Responsibility Act passed in June 2023, which can restrict future appropriations.

The authorizations were expected to enable additional appropriations to support NSF's current functions and activities while establishing the new TIP Directorate. NSF officials reported that they were preparing TIP to fully expend its appropriation should it match the amounts in TIP's authorization. As TIP started to create and post program solicitations, the amount of the award and number of awards were based on the authorized amounts. Future appropriations cannot be guaranteed, and the solicitations note that the number of awards and the award amount depend on available funding. Given the difference between the authorized and actual funding, NSF and TIP are adjusting operations and awards to fit within appropriations. See Appendix C for a further breakdown of TIP's budget at the division and program level.

Staffing of NSF

NSF's ability to staff the agency to meet the expectations of CHIPS is dependent on the AOAM and R&RA accounts. The AOAM account funds federal staff positions, while program funding from the R&RA account funds the Intergovernmental Personnel Act (IPA) assignees. NSF can also engage contractors in its work; however, they are not typically used heavily. As TIP has tried to

[12] NSF was in discussions with Congress about CHIPS and therefore had an idea of what kind of programs would be in the Act.

grow with its less-than-authorized budget and limited full-time equivalent (FTE) allocation, it has relied on contractors to handle more of the mission support aspects of the directorate. TIP has prioritized FTE staff and IPAs for more program-related roles to utilize their expertise to run the programs, instead of doing mission support tasks.

Table 3. TIP Staff Type Breakdown for FY2022-24[13]

	At Establishment (March 2022)	FY22	FY23	FY24
FTE	35	44	54	60
IPA	4	9	24	29

Source: TIP Office of the Assistant Director

NSF uses multiple authorities to bring new staff into the organization. Like other agencies, NSF relies on a mix of permanent federal employees and contractors. FTE allocation to directorates is determined centrally by NSF leaders.

Table 4. NSF Workforce (FTE) FY2021-24

	FY21	FY22	FY23	FY24
Request	1,656	1,829	1,889	1,967
Actual	1,650	1,733	1,921	TBD

Source: President's FY2021-24 Budget Requests

Almost all of NSF, including TIP, have received increases in FTE and IPA allocations since FY22.[14] What is distinctive about NSF is its extensive use of IPAs. IPAs are hired on a temporary basis, generally 1-2 years, from universities, nonprofits, and other government agencies with the intent of bringing in outside expertise as needed to inform the development and operation of programs providing funding to external research communities. The use of IPAs enables NSF to stay on the cutting edge of science and helps the Foundation stay current with developments in the various scientific communities the agency supports and apply relevant expertise to its programs.[15]

According to TIP officials, the directorate is distinctive among NSF directorates in its greater use of contractors. In FY23, contract positions make up almost 42 percent of TIP personnel. This partly reflects existing contracts used to support the SBIR/STTR programs that became part of the newly created directorate. These contracts have provided TIP with some additional flexibility to staff its efforts while it works to implement the ambitious CHIPS mandate in an uncertain fiscal environment. TIP has been able to expand existing contracts to assist with administrative and mission support work, including coordination of the merit review process. This is intended to free

[13] The table does not include contractors.
[14] FTE and IPA numbers from FY2021-23 for the directorates and offices were provided by TIP's Office of Assistant Director.
[15] "Intergovernmental Personnel Act (IPA) Assignments," National Science Foundation, accessed August 23, 2023, https://new.nsf.gov/careers/rotator-programs/intergovernmental-personnel-act-ipa-assignments.

up FTE and IPAs that have expertise and specializations that can be better utilized to develop and run TIP programs.

Table 5. AOAM Budget FY2021-24 (Dollars in Millions)

	FY21	FY22	FY23	FY24
Authorization	N/A	N/A	$620	$710
Request	$345.64	$468.30	$473.20	$503.87
Actual	$384.52	$420.21	$463.00	TBD

Source: President's FY2021-24 Budget Requests

From the FY21 budget request to FY22, NSF requested a $122.66 million increase in funding for the AOAM account. One of the reasons behind the increase was to address the needs of a growing agency with the establishment of TIP and expectation of operating with a $10 billion budget in the future. NSF expected the CHIPS legislation to increase staffing and operational needs, and therefore tried to account for the expected demands by increasing the AOAM funding. NSF's budget has grown in recent years and is expected to grow should authorized funding levels from CHIPS be appropriated. Within CHIPS, AOAM was authorized $620 million for FY23 and $710 million for FY24. The President's Budget requested $473.2 million for the FY23 AOAM budget and was appropriated $463 million, around $150 million lower than its authorization. The FY24 AOAM budget request of $503.87 million is around $200 million below its FY24 authorization. The gradual increase in the AOAM budget limits the amount of new FTE staff NSF can add each year.

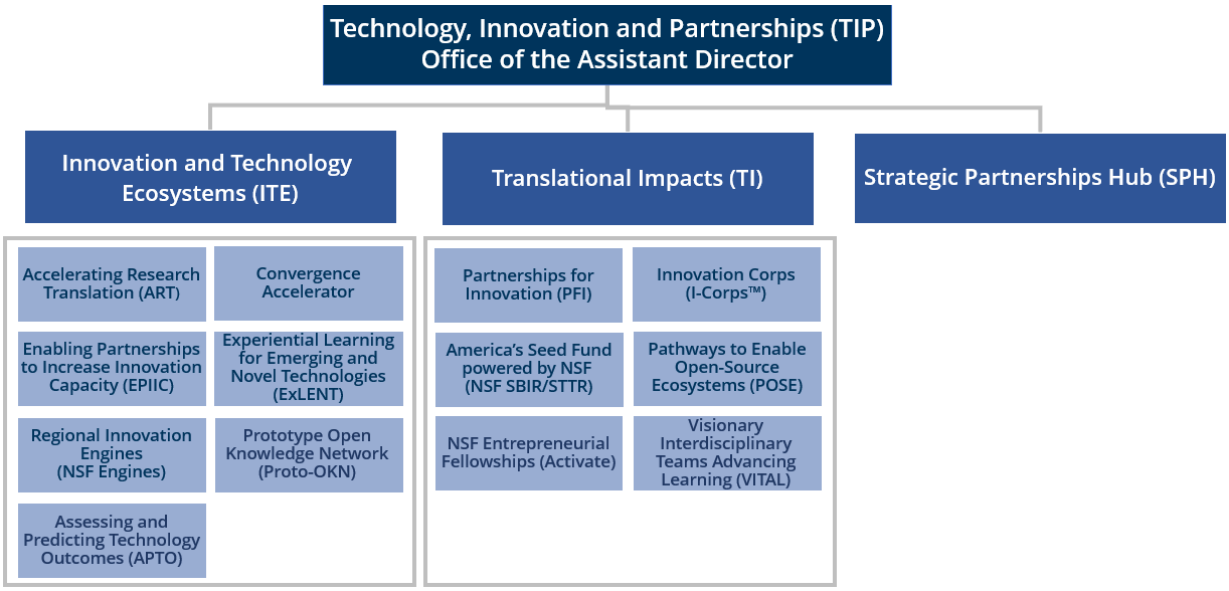
Over the years, NSF has used its transfer of funds authority to move money from the R&RA account to the AOAM account to cover administrative costs. Each year the transfer authority is approved with appropriations and allows NSF to transfer funds to increase the AOAM budget by no more than ten percent.[16] In FY23, NSF transferred $15 million to its AOAM account from the R&RA account.[17]

TIP Division and Program Descriptions

TIP is divided into five organizations: the Office of the Assistant Director (OAD), the Innovation and Technology Ecosystems (ITE) Division, the Translational Impacts (TI) Division, Technology Frontiers (TF) Division, and the Strategic Partnerships Hub (SPH). See Appendix D for program summaries.

[16] National Science Foundation. FY2023 Budget Request to Congress. Alexandria, VA, 2022. https://nsf-gov-resources.nsf.gov/about/budget/fy2023/pdf/fy2023budget.pdf.
[17] "Fiscal Year 2023 Appropriations," National Science Foundation, August 21, 2023, https://www.nsf.gov/about/budget/fy2023-appropriations.jsp.

Figure 2. TIP Directorate Organizational Chart[18]



Source: TIP Office of the Assistant Director

ITE focuses on building innovation ecosystems, accelerating technology development, and workforce development. To build innovation ecosystems, the programs emphasize cross sector work on emerging technologies and building infrastructure to advance new technologies and translation. Enabling Partnerships to Increase Innovation Capacity (EPIIC) and Accelerating Research Translation (ART) focus on building translational research infrastructure and capacity at institutions of higher education (IHEs), specifically at minority serving institutions (MSIs) and institutions with low levels of translational research activity. The Regional Innovation Engines (NSF Engines) and Convergence Accelerator (CA) programs focus on engaging multidisciplinary teams working on research that has long lasting national and regional economic and societal impact. NSF Engines is the flagship new program of the directorate because of its expansive mission focusing on workforce and regional economic development. To accelerate technology development, TIP started the Assessing and Predicting Technology Outcomes (APTO) program to help identify technology areas of interest, and the Prototype Open Knowledge Network (Proto-OKN) program which focuses on innovation in data, knowledge, and artificial intelligence (AI). To support workforce development, the Experiential Learning for Emerging and Novel Technologies (ExLENT) program was developed to engage individuals in workforce development opportunities for emerging technologies.

TI focuses on bridging the gap between scientific research and the marketplace and society through entrepreneurship education and partnerships. The Division provides programs to help innovators throughout the innovation process. I-Corps helps innovators determine if there is a market for their ideas through customer discovery interviews with relevant industry representatives. The Entrepreneurial Fellowships program through Activate gives fellows access to specialized facilities and equipment to promote use-inspired innovation and bridge the lab-to-

[18] The organizational chart does not include the Technology Frontiers (TF) Division because it is a virtual division operated out of TIP's Office of the Assistant Director.

market gap. Partnership for Innovation (PFI) walks through how to develop an innovator's idea all the way through creating a prototype. NSF's Small Business Innovation Research/ Small Business Technology Transfer (SBIR/STTR) programs invest in early-stage startups that can have a societal and commercial impact. There are also translational pathways. For example, the Pathways to Enable Open-Source Ecosystems (POSE) program helps create open-source ecosystems to spread innovation for the benefit of society and fellow researchers. The Division also promotes the Visionary Interdisciplinary Teams Advancing Learning (VITAL) prize challenge, encouraging interdisciplinary teams of researchers, startups, and small businesses to develop a prototype of their innovative ideas for learning technologies.

TF is a virtual division that is managed by TIP's OAD and partners with the other TIP units, other NSF directorates and offices, and other agencies, private industry, philanthropy, state and local government, civil society, and investors. Specifically, TF pursues innovation partnerships and collaborations across sectors, along with transformative mechanisms such as testbeds to accelerate research activities and scale outputs and impacts. An example of TF's work is the privacy-enhancing technologies (PETs) prize challenge run by TIP. The prize challenge gave participants the opportunity to take their research and see how they can apply it to address problems like financial crimes and public health emergencies, allowing researchers to take the first step in translating their work into privacy-enhancing technologies.[19] It also served as a useful model, exploring the prize challenge mechanism in the context of use-inspired and translational research.

The Strategic Partnerships Hub (SPH) focuses on assisting all NSF directorates in developing direct public and private partnerships to increase the visibility of NSF-funded research, innovation, and education to more sectors of society. The SPH will provide outreach strategies, technical guidance, MOU tracking, customer and partner management, and evaluation of NSF's external direct partnerships. There are no programs currently within SPH.

Overall, TIP programs work together and partner with other NSF directorates to engage various sectors to further the innovation and translation of new and emerging technologies that have societal impacts. TIP continues to develop existing and new programs to address its mission.

[19] "U.S. and U.K. Launch Innovation Prize Challenges in Privacy-Enhancing Technologies to Tackle Financial Crime and Public Health Emergencies," National Science Foundation, published July 20, 2022. https://new.nsf.gov/news/us-uk-launch-innovation-prize-challenges-privacy.

Chapter 3: TIP's New Approaches for Mission Delivery

The CHIPS and Science Act of 2022 (CHIPS) directed the Academy to identify gaps in NSF's institutional structures, procedures, or polices; identify inefficiencies; determine if TIP is appropriately resourced; and evaluate TIP's engagement of other directorates and federal entities. This chapter focuses on new activities initiated by NSF and TIP that are modifications or departures from NSF's basic research model.

CHIPS authorized NSF to establish the TIP Directorate to increase emphasis on use-inspired research, translation of research results, and to embrace diversity, equity, inclusion, and accessibility (DEIA) across its program offerings. Working closely with the NSF Director and the National Science Board, TIP leaders developed a portfolio of programs to coalesce people in academia, public sector, and private sector around CHIPS' goals that include, but are not limited to, engagement with non-traditional NSF partners, workforce development, organizational capacity building, innovation and technology transfer, and regional economic development.

The challenge for NSF was determining how to operationalize these goals. NSF approached it by relocating and expanding existing use-inspired and translational research programs (i.e., Convergence Accelerator, I-Corps, Partnerships for Innovation (PFI), and Small Business Innovation Research (SBIR)/ Small Business Technology Transfer (STTR)) into the TIP Directorate and developing new programs focused on addressing the gaps between current and new programs (e.g., Accelerating Research Translation (ART), Experiential Learning for Emerging and Novel Technologies (ExLENT), Pathways to Enable Open-Source Ecosystems (POSE), etc.). To do so, NSF and TIP developed both mission innovations and operational innovations.

Mission Innovations

Expanding TIP's Diversity of Participants

Advancing innovation, translation of basic research, and entrepreneurship touches many different communities of people and expertise. NSF has strong relationships with academia, notably R1 universities,[20] and small business entrepreneurs through the SBIR/STTR programs. These partners alone are insufficient to meet the mandates and expanded mission set out in CHIPS. TIP has been establishing working relationships with additional communities such as investors, venture capitalists, technology firms, and philanthropies, among others, to bring their experiences into the development and operation of TIP's program.

Additionally, TIP is bringing new individuals and organizations into the NSF community. TIP has programs (i.e., Enabling Partnerships to Increase Innovation Capacity (EPIIC) and Accelerating Research Translation (ART)) and program elements that will build the capacity of

[20] "Carnegie Classification of Institutions of Higher Education," Carnegie Classification, Accessed September 4, 2023, https://carnegieclassifications.acenet.edu/. R1 and R2 are designations of university research activity as defined by the Carnagie Classification of Institutions of Higher Education. R1 or "Very High Research Activity" institutions are the top tier of research universities, defined in part by amount of research funding, range of Ph.D. fields and number of awarded doctoral degrees. R2 or "High Research Activity" institutions are a category below R1.

underrepresented institutions, like minority serving institutions (MSIs), to directly participate in NSF awards. For example, TIP provides avenues for two-year institutions of higher education and R2 universities to apply for opportunities that will build their research capacity and familiarity with the NSF application and award process. In the Experiential Learning for Emerging and Novel Technologies (ExLENT) program, TIP and the STEM Education (EDU) Directorate are creating on-ramp opportunities for STEM-educated individuals who want to shift careers and providing workforce development through technical training to support the translation pathway.

Using Solicitations to Expand Participation and Build Capacity

One goal of TIP is to activate, engage, and grow use-inspired research and translation communities regardless of their sector or geographic location. This approach requires active outreach by NSF and TIP to identify and tap new respondents, partners, and non-traditional NSF communities. NSF's Equity Action Plan provides a framework for engagement.[21] TIP also is using additional selection criteria and consideration of broader impacts in its solicitations to assist its effort to engage a greater diversity of applicants.

An outreach strategy has been developed and implemented by TIP's leaders, who have communicated extensively the directorate's mission and purpose internally to NSF and externally to potential applicants and direct partners. TIP's leaders recognize that if they want to receive a diverse set of applicants, they must communicate TIP's funding opportunities to a wide and diverse population. They are achieving this through the use of multiple announcement mechanisms, such as Broad Agency Announcements (BAAs), as well as extensive in-person outreach to communities that can benefit from participating in TIP's program portfolio. TIP leaders and staff have given over 100 talks about TIP within the last year. Figure 3 provides a selection of the outreach efforts conducted by TIP.

Figure 3. TIP's Outreach to Communities

Selection of events from November 2022 to Present

• 10 Technology and Translation events for Academia
• 3 outreach events to underserved academic institutions:
  ○ Established Program to Stimulate Competitive Research (EPSCoR)
  ○ Louis Stokes Alliances for Minority Participation (LSAMP)
  ○ Historically Black Colleges and Universities (HBCUs)/Small Business Innovation Research (SBIR)
• 3 outreach events with HBCUs, Hispanic-Serving Institutions (HSIs), Tribal Colleges or Universities (TCUs), and two-year institutions
• 5 university outreach events
• 3 convening events with industry
• 10 events with nonprofits
• 14 events with state and local governments
• 4 events with private funding

Source: TIP Office of the Assistant Director

[21] National Science Foundation, *Agency Equity Action Plan*, n.d., https://www.nsf.gov/equity/NSF_Agency_Equity_Action_Plan.pdf.

The outreach effort to capture new and diverse participants in TIP's programs is echoed in the directorate's solicitations. TIP solicitations include additional selection criteria seeking a diverse set of applicants in the proposal. All TIP solicitations have, at minimum, a Diversity, Equity, Inclusion, and Accessibility (DEIA) criterion, and depending on the program, the criterion may be more expansive requiring a wide variety of individuals, organizations, sectors, or all of the above. For example, consider the following summaries of the diversity requirements for the Regional Innovation Engines (NSF Engines) and the Convergence Accelerator programs:

> **NSF Engines –** each Engine must demonstrate a strong commitment to diversity along several dimensions (e.g., perspectives, gender, types of organizations), equity, inclusion, and accessibility in intent, actions, and outcomes. In support of these objectives, the NSF Engines program seeks to expand the breadth of institution types that take on leadership roles in the program and regional-scale activities, such as Minority Serving Institutions (MSIs), institutions in EPSCoR jurisdictions, industry, and other organizations not traditionally supported by NSF.
>
> **Convergence Accelerator** – the parallel program solicitation and BAA require that each project include a Broadening Participation Plan that describes activities that will be undertaken to increase the participation of underrepresented groups in the project's research efforts. Examples of ways to engage groups and individuals that are underrepresented may include, but are not limited to: through the expertise of personnel, via partnerships, through work with users and user groups, via engagement with stakeholders, or through use of datasets that represent information about underrepresented groups.

Establishing Direct Partnerships and Coordination with External Organizations

NSF identifies two types of partnerships: direct partnerships and catalyzed partnerships. Direct partnerships are formal agreements, usually through a memorandum of understanding (MOU), between NSF and an external public (i.e., Department of Defense) or private organization (i.e., Intel) to invest in mutually beneficial efforts. See Appendix E for further description of partnership definitions. Direct partnerships with external organizations are not new to NSF. Table 6 lists the direct partnerships TIP has secured. However, the scale of partnership-based translation activities CHIPS authorized is substantially larger than previous efforts within NSF. Prior to TIP, the use of direct partnerships was inconsistent; some directorates used them extensively while others did not use them at all.

Table 6. List of TIP's Active Direct Partnerships

Program/Initiative	Partners
Building the Prototype Open Knowledge Network (Proto-OKN)	• NASA • NIH • NOAA • U.S. Geological Survey • DOJ/National Institute of Justice

Convergence Accelerator	• FY 2022 Track Partners
	  ○ Track G – DoD
	  ○ Track I – Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia
	  ○ Track J – USDA (workshops)
	• FY 2023 Track Partners
	  ○ Track J – USDA/National Institute of Food and Agriculture
	  ○ Track L – Vinnova and the Swedish Research Council, Sweden

Future of Semiconductors (FuSe)	• Ericsson • Intel • Samsung • Micron
Privacy-Enhancing Technologies (PETs) Prize Challenge	• NIST • U.K. Centre for Data Ethics and Innovation
Visionary Interdisciplinary Teams Advancing Learning (VITAL) Prize Challenge	• Bill and Melinda Gates Foundation • Walton Family Foundation • Schmidt Futures
Workforce Development Initiatives	• Intel • Micron

Source: TIP Office of the Assistant Director

Direct partnerships are a priority for TIP. The Strategic Partnerships Hub (SPH) was established to provide broad support for the development of partnerships across NSF. An example is the NobleReach Emerge partnership with the Directorate for Biological Sciences (BIO) funded by TIP. The partnership is focused on reviewing BIO's basic research for possible translation and partnership opportunities. SPH will centralize some functions previously handled by other parts of NSF, such as the tracking of active partnerships and the MOU repository formerly housed in the Office of Integrated Activities (OIA).

Federal direct partnerships are those between NSF and other federal organizations. As listed above in Table 6, TIP is engaged in multiple direct partnerships agreed to via an MOU. The purpose of these arrangements is to leverage resources and expertise for a common goal, such as

development of a Prototype Open Knowledge Network (Proto-OKN). [22] The Convergence Accelerator's Track G is another example. TIP leaders have partnered with Department of Defense (DoD) personnel to leverage DoD's and NSF's expertise to develop and securely operate through 5G wireless communications infrastructures. This type of partnership can maximize the investment potential of federal funds.

There are not many effective governmentwide mechanisms for agencies to coordinate programs and initiatives to avoid duplication and overlap. The National Science and Technology Council, run by the Office of Science and Technology Policy (OSTP) is the primary organization for convening federal entities with an interest and investment in science and innovation. Most of the important work is done by interagency policy committees and interagency working groups largely overseen by OSTP. CHIPS specifically established a working group through OSTP to ensure federal agencies coordinate and complement the programs and initiatives in the Act. The working group is tasked to focus and report on TIP's activities, particularly the NSF Engines program and testbeds; the Economic Development Administration's Regional Technology and Innovation Hubs; and the Department of Energy's intentions to address the key technology focus areas. Outside of these formal structures, opportunities for collaboration to achieve alignment of investments by federal agencies are driven by agency leaders through professional and personal networks.

TIP leaders are willing and capable to engage in interagency coordination on science and technology. TIP is seeking opportunities to coordinate with other agencies that have similar programs and goals. In July 2023, TIP signed a memorandum of understanding (MOU) with the U.S. Economic Development Administration (EDA) to coordinate regional economic development efforts between the TIP's NSF Engines and EDA's Regional Technology and Innovation Hubs. This collaboration is expected to leverage the investments of both TIP and EDA to drive innovation and develop regional economies.

Operational Innovations

TIP is experimenting with new approaches to perform mission tasks across its divisions and programs. The new approaches involve but are not limited to modifications in solicitation (i.e., who it goes to) and merit review (i.e., criteria and who reviews proposals), and capacity building to make sure a broader set of people are able to respond to proposals, serve on review panels, and receive NSF awards. Additional efforts include utilizing new hiring authorities to recruit staff for a non-traditional set of skills and experiences to support these initiatives. Implementation of these approaches will entail defining and integrating the distinctive needs of the expanded mission mandate into the operations of NSF. This will entail not only changes in process, but changes in the culture of the organization to fully enable the revision or development of new approaches.

Solicitation Development and Merit Review

Translation pathways involve a diversity of professions from basic research to entrepreneurship expertise. In a change for NSF, TIP is involving these professionals more directly in the

[22] See Appendix D for further details on the Proto-OKN program.

development of programs and solicitations and as merit reviewers for awards. These efforts are consistent with NSF's *Proposal and Award Policies and Procedure Guide*.[23]

The overarching goal is to expand the staff and universe of merit reviewers beyond academia to include points of view from venture capital, foundations, industry, and others to select the most promising proposals submitted to TIP. NSF has a successful history of bringing academic, nonprofit, and public sector individuals to the Foundation as temporary employees through the Intergovernmental Personnel Act and other staffing vehicles to stay on the cutting edge of research. TIP uses the same staffing vehicles to diversify expertise by hiring rotators from industry and the private sector in addition to academic, nonprofit, and public sector individuals. With the diverse staff experience, NSF expects that TIP can create program solicitations that can better engage various communities and industries.

As a part of the merit review process, these individuals bring their diverse experiences to the selection of proposals through interactive review panels. Having the expanded reviewer pools has the additional benefit of creating an open dialogue for the future where these organizations can refer promising efforts to NSF that don't fit their investment parameters but may align with TIP's parameters for consideration in the competitive awards processes. This simultaneously helps TIP award the most promising applications and expands the pipeline of project proposals submissions.

New Announcement Approaches for Funding Opportunities

TIP is broadly publicizing its programs and award opportunities to increase the participation of new applicants and the number of applications received. Traditionally, NSF uses program solicitations or program announcements, or posts Dear Colleague Letters to the NSF website, which are followed closely by most academic research institutions but do not reach a larger audience. To increase TIP's visibility in nontraditional communities, TIP uses mechanisms like Broad Agency Announcements (BAAs) to broadcast its program solicitations to new communities. For example, the NSF Engines funding opportunity was issued as a BAA through SAM.GOV to ensure the visibility of the opportunity in industry and non-academic communities.

New Types of Financial Agreements

NSF's basic research is typically funded through financial assistance grants and cooperative agreements. TIP has been authorized a unique financial tool not previously available to NSF. CHIPS provided TIP with Other Transaction Authority (OTA), which has been used by other federal organizations such as NASA and DARPA to drive technological innovations. OTA is different than NSF's current authorities because it does not abide by the Uniform Guidance and Federal Acquisition Regulations that apply to grants, cooperative agreements, and contracts.[24] Currently, TIP has been working with the Division of Acquisition and Cooperative Support

[23] "Proposal & Award Policies & Procedures Guide (PAPPG)," Document Library, National Science Foundation, Posted October 31, 2022, https://www.nsf.gov/publications/pub_summ.jsp?ods_key=papp.
[24] Summary of Federal OIG Findings and Recommendations Related to Other Transaction Agreements. National Science Foundation Office of the Inspector General. Report No. 23-6-001. March 3, 2023. https://oig.nsf.gov/sites/default/files/reports/2023-03/23-6-001-Other-Transaction-Agreements.pdf.

(DACS) within the Office of Budget, Finance and Award Management (BFA) and the Office of General Counsel to develop protocols for use of OTA.

TIP is also using cooperative agreements as an award mechanism instead of traditional grants. NSF's familiarity with cooperative agreements is typically for research facilities and not as a program award mechanism, which requires some adjustment by the Contracts Branch to adapt to the new use of a familiar tool. The cooperative agreement relationship requirements for the Program Director (PD) and the awardee are better suited to support TIP's programs, compared to grants. For TIP programs, the PD is expected to be an active participant in the work of the awardee. This shifts the role from a PD focusing on contractual and financial oversight to the PD being an active performer and providing ongoing technical support and advice to the awardees. This echoes DARPA's project management approach.

Currently, there is an Award Instrument Working Group that is assisting staff members in determining the mechanisms for determining the best award instrument for different programs and funding opportunities. NSF is also piloting an internal process to assist employees in determining which financial vehicles are most appropriate for their funding opportunities.

Internal Collaborations

Although TIP increases funding for use-inspired research and educational efforts, NSF will continue to be a leader in basic research and scientific inquiry. TIP is dependent on the production of basic research results for possible translation into market and non-market goods or services. Therefore, relationships among all of NSF's directorates are essential for TIP.

Cross-organizational communication is a hallmark of NSF's collaborative internal culture. NSF has many avenues of cross-agency communication, including working groups, Assistant Director meetings, Deputy Assistant Director meetings, and informal communication. As a new directorate with both preexisting and newly established programs, TIP's ability to establish and maintain strong relationships with NSF's other directorates through working groups or other means is foundational to its mission. Realizing its importance, TIP leaders intentionally set aside funding to support collaborative and cross-directorate initiatives to seed and grow these new working relationships. Additionally, formal relationships being established through the Strategic Partnerships Hub (SPH) will extend TIP's avenues for communication across NSF. Today, TIP has partnerships in place with every other NSF directorate.

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Chapter 4: Challenges to Achieving and Sustaining TIP's Mission

This chapter considers challenges that could hinder TIP in successfully carrying out its mission over time and recommendations for addressing them.

- Developing Clear Strategies, Goals, and Metrics
- Effectively Resourcing TIP's Mission
- Integrating TIP Needs into NSF-level Mission Support
- Institutionalizing an Expanded Mission at NSF

Developing Clear Strategies, Goals, and Metrics

Effective strategic planning and performance measurement are important tools to strengthen an organization's abilities to effectively fulfill its mission. High performing organizations have formal, ongoing strategic management processes in place with clearly defined missions, goals, objectives, and performance metrics to drive change, measure progress, establish accountability, engage stakeholders, and set expectations.

TIP was established in March 2022, and its strategic planning process is currently in development. Best practice research highlights the importance of establishing a formal strategic planning process to develop strategic goals, objectives and performance measures that support effective monitoring and accountability for key stakeholders. It also enhances an organization's ability to adequately plan for effective resourcing in the current fiscal year and for future fiscal years.

TIP officials acknowledged the importance of strategic planning and described multiple planning efforts within the directorate to set future direction and identify priorities. For example, CHIPS identifies the initial list of societal, national, and geostrategic challenges and key technology areas for NSF and TIP to focus on. NSF is required to review the list annually and update it as necessary and deliver a report to Congress based on its review.[25] Additionally, TIP is expected to submit to Congress every three years a five-year strategic vision that will guide the directorate's activities.[26] Moreover, the legislation tasks NSF to develop a technology roadmap to guide the directorate's research and workforce investments over a three-year timeframe and submit to Congress an annual report on TIP-supported projects.[27] TIP issued a Request for Information (RFI) to solicit input from external stakeholders across all sectors (e.g., industry, academia, government, venture

[25] CHIPS and Science Act Section 10387: The annual report should describe: (1) the key technology focus areas and rationale for their selection; (2) the societal, national, and geostrategic challenges and rationale for their selection; (3) the role of the Foundation in advancing the key technology focus areas; (4) the impact, including to the academic research community, of any changes to the key technology focus areas; and (5) the activities and partnerships between the Directorate and the private sector.
[26] CHIPS and Science Act Section 10399 (c). In addition to the five-year strategic vision, this section also requires NSF to provide "a description of the planned activities of the Directorate to secure federally funded science and technology."
[26] CHIPS and Science Act Section 10399 (a) and (b).

capital, etc.) to inform the development of the roadmap,[28] and contracted with a Federally Funded R&D Center (FFRDC) to review and synthesize the comments received in response to the RFI. TIP also sent the same RFI to NSF staff members to collect their feedback. TIP officials noted that the plan is to share the draft roadmap with top NSF leaders and the National Science Board (NSB) to ensure the alignment between the roadmap and NSF's overall strategic direction. The goal is to deliver the roadmap to Congress by the end of 2023.[29] As understood from conversations with TIP officials, the Technology Roadmap will serve as the basis for the directorate's strategic plan.

In addition to TIP-specific planning efforts, TIP's programs and activities are guided by NSF's agency-wide strategic plan. NSF has a unique dual leadership structure, with the Director of the agency and NSB responsible for setting the overall direction for the agency. In its 2022-2026 Strategic Plan, NSF emphasizes the synergy between basic and use-inspired research and the importance of expanding use-inspired research and accelerating the translation of scientific discoveries into commercial and/or societal outcomes.[30] One of the strategic goals identified in the agency's plan is "benefit society by translating knowledge into solutions,"[31] and specifically, Strategic Objective 3.1—"advance research and accelerate innovation that address societal challenges"—highlights the agency's commitment to expanding use-inspired research and research translation. TIP's efforts broadly support this NSF strategic goal and objective.

TIP is also included in NSF's Learning Agenda, which identifies a set of Guiding Questions and Priority Questions that reflect the agency's learning priorities and support the implementation of the NSF Strategic Plan. One of the key areas identified in NSF's Learning Agenda is maximizing impacts of NSF-funded research (Guiding Question: "How can NSF mobilize knowledge most effectively to impact society?"). Additionally, the Learning Agenda contains some specific questions to help the agency assess progress on its partnership efforts and the Convergence Accelerator program (Appendix D provides a summary of TIP programs).[32]

Solid performance measurement is critical to successful implementation of the strategic plan. It allows an organization to track progress toward achieving goals and objectives, assess the effectiveness and efficiency of organizational programs and operations on a regular basis, and establish accountability.

TIP is still in the early stages of developing its performance measurement system. Many interviewees noted that there have been internal discussions regarding performance metrics and

[27] "Request for Information (RFI) on Developing a Roadmap for the Directorate for Technology, Innovation, and Partnerships at the National Science Foundation," National Science Foundation, Federal Register, Published April 28, 2023, https://www.federalregister.gov/documents/2023/04/28/2023-08995/request-for-information-rfi-on-developing-a-roadmap-for-the-directorate-for-technology-innovation.

[29] CHIPS requires that NSF deliver the roadmap no later than 1 year after the date of enactment the Act (i.e., August 2022); TIP officials said that they planned to deliver the roadmap by the end of 2023 due to the longer than expected timeline to sign a contract with the FFRDC.

[30] The NSF Strategic Plan (FY 2022-2026) was developed before CHIPS was passed and TIP was formally established.

[31] National Science Foundation, 2022-2026 Strategic Plan, March 2022, p. 40, https://www.nsf.gov/pubs/2022/nsf22068/nsf22068.pdf.

[32] National Science Foundation, Learning Agenda FY2022-2026, March 2022, https://nsf-gov-resources.nsf.gov/2022-04/NSF_FY22-FY26%20Learning%20Agenda%20Final.pdf.

management. The directorate has not formally articulated yet its metrics and outcomes, but has several supporting efforts underway including development of a Technology Roadmap, program logic models and metrics, and a Value Creation Framework with TIP-level goals and metrics. Multiple interviewees emphasized that, given the unique mission of TIP, traditional research metrics (e.g., publications, conference proceedings) are not sufficient to measure TIP's outcomes. TIP is exploring ways to assess potential impacts of innovation and research translation. For example, TIP hosted a data and analytics symposium earlier this year and invited three panels from academia, other federal agencies, and non-governmental organizations (NGOs) to discuss the most effective "non-traditional" performance metrics. In addition, TIP is reaching out to other federal agencies that also focus on use-inspired research and translation of research (e.g., Department of Energy Office of Technology and Translation's Commercial Adoption Readiness Assessment Tool) to learn how they develop evaluation frameworks and identify best practices.

At the program level, the preexisting programs moved to TIP already had established reporting requirements for performance metrics. For example, the I-Corps program is required to report metrics to Congress every two years in four areas, including training an entrepreneurial workforce, translating technologies, enabling economic impact, and nurturing an innovation ecosystem. Appendix F provides a list of reporting requirements for preexisting programs. Most new TIP programs are in the process of drafting their evaluation components and performance metrics. This process has been slow because efforts to develop goals and metrics were being handled as a collateral duty by program staff who were simultaneously managing daily operations.

TIP is in the process of developing the Value Creation Framework to guide the directorate-level performance measurement and evaluation efforts. The Framework is built around the three pillars of TIP—diverse innovation ecosystems, technology translation and development, and workforce development. Under each pillar, the Framework identifies a list of initial goals and performance metrics/indicators. In FY23, NSF provided funding for one FTE position (i.e., TIP Staff Associate for Evaluation and Assessment) to take the lead in developing the draft Framework with input from the leadership team and industry experts.[33] The Framework was initially discussed with TIP staff at a retreat in September 2023.

Interviewees noted that the Framework was designed with a goal to ultimately have a set of aligned top-down directorate measures and bottom-up program-level measures. This Framework is intended to capture the crosscutting impacts of TIP's programs. Regardless of grouping or division, all the programs share a common focus on increasing the diversity of people, sectors, and geographies involved; developing new capacities among NSF's stakeholders; and accelerating progress in the ten technology and five societal, national, and geostrategic challenge areas identified in CHIPS. Interviewees also noted that logic models are being developed for all new and preexisting programs along with the development of directorate level metrics.

While the draft Value Creation Framework is a good start, performance metrics ideally should flow from an organization's strategic plan. However, as discussed earlier, TIP' strategic planning

[33] In addition to the Staff Associate for Evaluation and Assessment, TIP also has a Staff Associate for Data and Analytics who assists in the development of metrics and presentation of data (e.g. NSF Engines Dashboard and NSF Insights.)

process is still in development and therefore, TIP has not formally articulated its goals and desired outcomes. In the absence of a completed strategic plan with clearly defined priorities, goals, and objectives, it is not possible for the Panel to assess the effectiveness of the draft Framework and metrics in ensuring alignment between TIP activities, decision making, and NSF's strategic direction. The Value Creation Framework is being developed in parallel with the Technology Roadmap, and the next step should be integrating and aligning the directorate's goals and objectives with performance metrics.

At the agency level, in its Annual Performance Plan, NSF identifies a set of performance goals and metrics to track the agency's progress toward attaining its strategic goals and objectives. There should be a clear line of sight from the agency's goals, objectives, and performance metrics to directorate goals and metrics. However, while TIP's draft performance goals and metrics are connected with NSF's metrics in a couple of areas,[34] there is no strong linkage between the agency-level performance metrics and the draft TIP goals and metrics.

TIP's Value Creation Framework also does not contain any operational efficiency metrics. At the agency level, according to some interviewees, while the Annual Performance Plan has some operational metrics, NSF does not have an operational dashboard that provides leaders with a holistic view of the operations of the entire agency. TIP should develop and use metrics to assess TIP's operational efficiency (e.g., time required to develop a MOU[35]) and better understand how TIP executes various business processes.

The range of activities occurring under the TIP umbrella is large, including developing STEM workforce opportunities, funding entrepreneurs for technology startups, and measuring the economic impact of the NSF Engines program. TIP's current planning and performance management approach has involved many separate efforts without a clear link to NSF's planning and performance management efforts. A more formal, integrated strategic management process would help TIP connect individual efforts and initiatives to a shared vision, foster a sense of unity, and ensure continued agency progress.

Recommendation 1: TIP should establish a formal, integrated strategic management process that clearly produces the directorate's priorities, strategic goals, objectives, strategies, and performance metrics.

Good practice elements for TIP leadership to consider include:

- Leverage existing planning efforts.

[34] TIP's draft performance goals and metrics are connected with NSF's metrics in a couple of areas. For example, NSF's Annual FY 2024 Annual Performance Plan identifies a performance goal to "grow partnerships" (Annual Goal 3.1), and more specifically, NSF sets the goal to increase funding from industry, non-profits and other agencies that NSF programs leverage to support the STEM enterprise. Another example is NSF's annual performance goal to "improve representation in the scientific enterprise" (Annual Goal 1.1)—increase both number and proportion of proposals from principal investigators from underrepresented groups and underserved institutions.

[35] The Panel recognizes that some activities (e.g., developing a MOU) involve other NSF offices, such as the Office of the General Counsel, the Office of Budget, Finance and Award Management, etc. The Panel's recommendation focuses on TIP's operational actions.

- Develop the strategic plan through a collaborative process and solicit input from an array of stakeholders, such as Congress, other organization components, other federal agencies, industry, researchers, non-profit organizations, etc.
- Treat the strategic plan as a living document and provide continuous review and revision.
- Continue to reach out to other federal agencies to identify best practices for developing performance metrics to measure outcomes and impacts of research translation.
- Provide training to managers and staff to build expertise in strategic planning and performance measurement for translation work.
- Align the organization's plans and performance metrics and individual performance expectations with the organization's strategic direction.
- Promote effective performance management through an ongoing process that collects performance data, uses the information to inform decision-making, and improves performance.

Effectively Resourcing TIP's Mission

The congressional mandate in CHIPS entails a substantial expansion of NSF's existing responsibilities, including a greater emphasis on use-inspired research and efforts to translate research results into practice and a largely new focus on stimulating the development of industry clusters in particular geographic areas. The mandate also calls for a greater emphasis on increasing the diversity of participants in NSF's efforts across the board. Appropriate funding will be necessary to resource these efforts.

Aligning TIP's mission with available resources will present challenges in the following four areas:

1. Sustaining long-term funding for and participation of awardees
2. Staffing TIP programs
3. Supporting NSF's direct partnership efforts—Strategic Partnerships Hub
4. Prioritizing effort and resources

Sustaining Long-Term Funding and Participation

To achieve NSF's expanded mission focus, TIP has received funding to grow its preexisting programs and develop new ones. Increasing the number of award opportunities will incentivize the participation of traditional NSF communities in new geographic regions and of underrepresented communities that either have not participated in NSF programs previously or only participated on the margins. Expanding funding opportunities to new regions and communities is a recruitment tool to expand the diversity of participants engaged with TIP. In the case of NSF Engines, as well as some other TIP programs, some awards are intended to support actions that will take multiple years. Although an award may span over multiple years, awardee funding and assessment occur annually, unless otherwise specified.

Specifically, the NSF Engines program is intended to promote the development of new industry clusters in parts of the country that have not enjoyed the same economic success associated with the coastal regions of the country. NSF Engines is one of TIP's largest investments, with the potential of $160 million over ten years per awardee for a Type 2 NSF Engines award. Appropriations in 2023 were sufficient to support the 44 Type 1 development awards, which are

up to $1 million for two years.[36] However, as the program moves towards awarding the Type 2 Engines awards in outyears, there is a concern that constrained federal budgets may lead to funding reductions for the program—either fewer awards being made or reductions in the total amount per award. Currently, TIP aims to award a maximum of five Type 2 NSF Engine awards in the winter of 2023, with each awardee receiving about $15 million over the first two years of the award.[37]

Staffing TIP Programs

TIP creates unique demands on staff members in administering its programs and awards. The use of cooperative agreements is a case in point. TIP has elected to use cooperative agreements, instead of grants, in many of its programs. The benefit of this approach is that program directors (PDs) become more active participants in the work and outcome of the award. The opportunity cost is that PDs spend more time per award on cooperative agreements providing active and ongoing support to the awardee than they would for a traditional research grant. The result is that the number of available PDs at TIP is stretched thin as they absorb the increased workload associated with cooperative agreements.

At the same time, the nature of the work is changing for the PDs. For example, NSF staff have extensive experience managing grants and agreements for basic research. However, TIP's use of cooperative agreements for use-inspired research and development of innovation ecosystems is less prevalent. In addition, the use of Other Transactions Authority (OTA) is new to NSF. The skill set for a PD overseeing a basic research grant is different than a PD supporting the development of large, catalyzed partnership network focused on economic growth. A TIP PD needs to be able to manage both the award instrument (i.e., cooperative agreement, OTA) and have the "soft" skills to work cooperatively with awardees to achieve outcomes, and "hard" technical and/or professional experience to bring research through translation. TIP leaders will have to continue to identify, train or hire staff with these particular skillsets.

TIP leaders meet regularly to discuss staffing of the organization and to identify both how many employees are needed to balance the workload, and what the necessary skill sets are to carry out the new responsibilities of a PD. TIP leaders have worked together with NSF's Division of Human Resource Management (HRM) to develop new position descriptions that take into account professional experience qualifications beyond academia to allow non-academics to come in at the GS or AD level that matches their experience (see Figure 5). TIP leaders are actively recruiting staff. Some staff have transferred from within NSF, others have come from other federal agencies like DARPA and NASA, while others have come from academia, venture capital, industry, and small businesses.

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[36] The NSF Engines program has two types of awards. The Type 1 award, also referred to as a development award, is an up to two years $1 million award that is intended to help awardees lay the groundwork for developing an NSF Engine. The Type 2 award, an NSF Engine award, is expected to be an up to ten-year award with up to $160 million in funding to establish the NSF Engine. NSF expects to award five of the Type 2 awards for the FY22 solicitation. A Type 1 award is not a prerequisite for the Type 2 award and Type 1 awardees need to reapply if they would like to pursue a Type 2 award.

[37] "NSF Regional Innovation Engines program selects 16 teams for the final round of competition." NSF News, National Science Foundation, Published August 2, 2023. https://new.nsf.gov/news/nsf-regional-innovation-engines-program-selects-16

Figure 4. Example of new experience requirements for TIP

Position: Program Director for the Innovation Technology Ecosystem (ITE) Division
Required experience, pertinent to the position, includes experience in areas such as: ✓ Translation of research results to practice ✓ Building innovation ecosystems ✓ Venture capital experience ✓ Public policy ✓ State and local government ✓ Economic development ✓ Entrepreneurship experience of any kind is preferred, but not required.

Source: TIP Office of the Assistant Director

Recommendation 2: TIP leaders should develop a strategic workforce planning process to regularly determine if they have the (1) number of staff needed to support the directorate's workload, and (2) staff members with the correct skill sets to support the nature of their work. TIP leaders should develop their workforce strategy based on their ongoing discussions with NSF leaders and mission support.

Supporting NSF's Direct Partnership Efforts—Strategic Partnerships Hub

TIP's Strategic Partnerships Hub (SPH) is intended to assist and support direct partnerships for all NSF directorates to advance research, innovation, and education across NSF and beyond NSF investment. Direct partnerships have legal, financial, and ethical implications for the Foundation. The goal is to establish SPH with the expertise and authority required to set strategy and provide policy and guidance on partnerships for all of NSF. SPH will centralize and maintain existing partnership resources and assist NSF directorates in forming and maintaining direct partnerships. Additionally, TIP leaders see SPH's role as the central point of contact for partnerships for NSF that will work on intaking and connecting potential partners with directorates and programs that share their interests.

Prior to SPH, the resources and functions for supporting partnerships were spread across NSF. The MOU repository was in the Office of Integrative Activities (OIA) and direct partnerships for directorates were handled by individual directorates without centralized resources or assistance. Until recently, TIP did not have enough available appropriations nor FTE to staff SPH because the priority was operationalizing its new programs to fulfill the mandates in CHIPS. Due to the limited appropriations and FTE, this function remained a collateral duty for senior TIP leaders and employees. NSF's FY23 appropriation was allocated to provide TIP FTE and funding to formally establish SPH. The Hub will have four FTE positions by FY24. It is currently staffed by one FTE, a Strategic Partnerships Officer, and TIP leaders are working to fill the other Strategic Partnerships Officer position and two SES positions, SPH Director and Deputy Director.

The SPH will focus on maintaining and improving existing resources and creating new tools to improve partnership management. SPH will operate the MOU repository, soon to be replaced by the Partnership Agreement Repository and Tracking Application (PARTA), to make tracking and reporting on MOU agreements easier based on a searchable database of previous MOUs and related documents. The new SPH staff and the TIP Staff Associate for Strategic Engagement are also working to streamline the MOU process. Additionally, TIP hopes to implement a customer relations management tool to track NSF's external partnerships engagement. If SPH cannot find a suitable existing tool or application, they will develop new ones in-house, like PARTA. Additionally, SPH will work on updating the internal partnership portal and the external partnership website.

SPH's NSF-wide partnership engagement responsibilities include meeting with the partnership coordinators for each directorate, connecting potential partners to directorates, and engaging NSF staff in discussions around partnership. The new Strategic Partnerships Officer is meeting with each of the NSF directorates' partnership coordinators to learn what has worked and not worked in the past for partnerships. Some directorates have more experience in partnering than others, so there is an intention within TIP to help those with less experience engage in more partnerships, particularly ones with a focus on use-inspired research. For example, prior to standing up SPH, TIP was able to connect the BIO Directorate to potential partners and let the directorate determine if it would pursue them. For partnerships BIO chose to pursue, TIP made itself available to assist the directorate in managing them. SPH is also responsible for restarting the internal NSF partnerships community of practice discussions. The partnerships community of practice were brown bag discussions that NSF employees could attend to learn about partnerships and discuss their experiences, which helped pool lessons learned from staff across NSF. The discussions were discontinued in September 2022 with the expectation of SPH becoming responsible for hosting them.

The development of direct partnerships is an important function for supporting NSF's expanded mission. TIP's SPH is envisioned to be a centralized resource that supports all aspects of direct partnership development, from outreach to MOU, for TIP and all other NSF directorates. As SPH becomes a reality, its responsibilities will have to be further defined.

Recommendation 3: Senior leaders of NSF and TIP should jointly develop an implementation plan for the Strategic Partnerships Hub (SPH) that prioritizes the Hub's responsibilities and resource needs for continued development and growth.

Prioritizing Effort and Resources

Given likely future resource constraints, effective prioritization of investments is critical. NSF leaders have already made certain priorities clear. Establishing TIP at NSF while also maintaining support for basic research was an investment priority. NSF allocated substantial funding and staffing to establish TIP, increased funding and staffing for mission support functions (i.e., IT, HR, etc.), and provided new program funds and FTE to all NSF directorates.[38]

[38] Funding and FTE allocations for TIP are described in detail in Chapter 2. For NSF budget and FTE allocations, see Appendix G.

The NSB and NSF are working closely together to implement CHIPS by making TIP fully operational as soon as possible. It was a priority for NSF to operationalize TIP's programs and get appropriated funds awarded in a timely manner. TIP has multiple efforts underway to assist its prioritization efforts. TIP's leaders, in consultation with NSF, NSB, academia, industry, and many other sectors, are developing priorities for investment. These priorities will need to be revisited annually based on NSF's appropriations to ensure the integrity and sustainability of TIP's programs.

Within TIP, providing continuous guidance and technical support to the awardees is a leadership priority. The use of direct partnerships is time intensive for the PD. In interviews, TIP leaders have stated that they prioritized allocation of staffing across its programs based on expected workload considerations. A priority staffing gap for TIP is the need for more PDs to handle the growth in programs and awards, and the administration of cooperative agreements and Other Transaction instead of grants. This priority intersects with TIP's desire to hire staff with skills sets appropriate for developing partnerships, translating research, and bringing innovations to market (e.g., through entrepreneurship).

Integrating TIP Needs into NSF-level Mission Support

NSF has staff that directly support processes and transactions that are common across directorates. These "mission support" functions include HR, budgeting, IT, grants management, contract management, and others and are primarily located within the Offices of Budget Finance and Award Management (BFA) and Information and Resource Management (OIRM). Integrating TIP's particular business processes and authorities into NSF mission support will require modifying or developing new policies and procedures, and training or hiring staff with the skillsets needed to operationalize them.

TIP represents changes in the nature of work and workload at NSF. This change cascades into mission support which must adapt by training or hiring people with new skillsets and/or experience that complement TIP's business model, such as the use of cooperative agreements for the development of innovation ecosystems or OTA for actions/activities. Additionally, a new directorate at NSF increases the overall workload for mission support which might require NSF reallocating or requesting additional staff.

The TIP Directorate is a combination of existing and new programs. Some NSF programs were transferred to TIP with existing staff, business process, and workloads. The new programs in TIP require new staff skillsets and business processes. From an NSF mission support perspective, the preexisting programs' mission support needs have already been captured; for the new programs, the mission support needs are still being determined.

NSF's FY23 appropriations provided additional FTEs that were allocated across NSF, including for mission support functions. For example, BFA and OIRM received 9 and 21 FTE, respectively. These additions will add to the capability of mission support to provide for the entire agency and ease the workload impact associated with the integration of TIP. Moving forward, NSF will have to balance maintaining mission support for the entire agency while meeting TIP's needs as it continues through its stand-up phase.

The changes in NSF-level mission support needed by TIP are substantial. They include new position descriptions and personnel performance metrics with the Division of Human Resource Management (HRM), new contracting authorities and development and review of MOUs for partnerships with the Office of General Counsel (OGC), and additional risk profiles for cooperative agreements with BFA.

TIP leaders are working hand-in-hand with NSF mission support organizations to expedite the integration of TIP as issues arise. This is a labor-intensive process that is not sustainable in the long term. To streamline this process, TIP leaders intend to meet with TIP division and program leaders to reflect on what has worked well and identify and prioritize outstanding mission support needs.

Recommendation 4: TIP leaders should work collaboratively with NSF and mission support leaders to develop a plan that identifies and prioritizes mission support resource opportunities and challenges that must be addressed to enable the successful performance of NSF's expanded mission focus.

Institutionalizing an Expanded Mission Focus at NSF

CHIPS authorized NSF to take on an expanded mission focus. This mandate begins with an understanding of NSF's core mission of supporting the basic research enterprise but calls for greater emphasis in several areas. As discussed earlier, these areas include use-inspired, basic research, translation of research results into social and economic impact, and increased diversity of participation across the life cycle of research and translation efforts, including increased geographic diversity of investments to enable broader participation in the fruits of research. NSF has a history of efforts in these areas, but until now it has not had a clear mandate to pursue these foci at the enterprise level.

To lead the implementation of this expanded mission focus, CHIPS also authorized the creation of the TIP Directorate. However, congressional authorizers recognized that TIP would not be acting alone, as reflected in the report mandate to the Academy. The success of TIP will depend on its ability to leverage the capabilities of the NSF enterprise, and on the willingness and ability of NSF leaders to enable TIP efforts. The organizational effort required for success in integrating and supporting this enhanced mission focus will be non-trivial, entailing not only additional resources, but the reorientation of some mission support efforts across NSF. Moreover, the success of this mission will require action by TIP leaders to help create and maintain productive collaborations across NSF's diverse programs.

As discussed in Chapter 3, TIP leaders have been experimenting with new approaches to executing both existing and new programs in keeping with the congressional mandate. The goal is to identify what works and institutionalize good practices. Institutionalization is the process of translating new practices into normal practice, and it should be understood in terms of change management. Translating new practices into routine requires sustained effort. It begins with the active support of top leaders and includes regular communication, development of written policies and procedures, and related training. It also includes aligning the incentives of leaders, management, and staff with the goals of the enhanced mission by evaluating and rewarding them based on criteria related to measuring progress.

The Panel believes that change management is essential to the successful implementation of NSF's expanded mission mandate. As noted, this will include sustained leadership at the agency level, systematic communication, the creation of policies and procedures and related training. A fuller discussion of change management good practice is provided in Appendix H.

Specifically, the Panel identifies three focus areas for identifying and institutionalizing good practice. Two of these are addressed earlier in the report. The first of these was NSF-level efforts to provide the required mission support functions (e.g., IT, HR, etc.) for TIP and translating this into standard policy and procedure. The second was the partnership function, in which case TIP will be providing mission support to NSF but will still depend to some extent on administrative support provided at the agency level, such as hiring. The third section, below, focuses on challenges and opportunities for institutionalizing good practice regarding collaboration between TIP and other NSF directorates.

Collaboration Between TIP and Other NSF Directorates

The ability of NSF to successfully implement its expanded mission focus will require active collaboration between TIP and other NSF directorates, including the basic research directorates and EDU, which funds cross-cutting activities including workforce development. NSF's basic research directorates fund cutting-edge research and employ permanent and temporary expert staff ("rotators") from outside the agency to constantly refresh NSF's subject matter expertise. TIP will depend on active collaboration with the basic research directorates' expert staff to be able to identify research results that might have the potential to be translated into high-impact innovation. More generally, TIP needs expert support from the directorates to inform the development of its programs, solicitations, and merit review processes.

Collaboration cannot be compelled, and TIP does not have authority over other directorate staff to do so in any case. Interviews suggest that TIP staff is doing its best to offer compelling rationales for collaboration and that there is substantial enthusiasm among basic research directorate staff to participate in the enhanced mission based on perceived opportunities to translate research results into impact. However, current enthusiasm cannot be relied on over the longer term. Investments in substantive collaborative efforts ultimately require tradeoffs in terms of both staff time and funding. NSF has received an increase in appropriations over the last few years, and each directorate has benefited from it. Additionally, TIP has been able to set aside some program funding for use in collaborative efforts with the other directorates, such as co-funding solicitations. That said, the federal budget is expected to become more constrained in future years. Given limited resources, NSF directorates must weigh investments in cross-directorate collaborations against their own particular priorities. In a more constrained resource environment, the basic research directorates may be less willing to provide the level of collaboration to TIP as they do today.

Funding is key to facilitating collaboration among organizations where objectives may overlap but are not completely aligned. As mentioned, TIP has been able to set aside some money to support the co-funding of proposals with other directorates, and EDU has been able to help support collaborations within its mission responsibilities. That said, this funding situation may not continue.

In light of an uncertain budget environment, it is important to acknowledge and reward collaboration across directorates consistent with the demands of accomplishing the expanded mission mandate. Otherwise, the priorities of individual directorates and programs may edge out collaboration. One good practice is to give credit to responsible staff for time and effort spent on relevant collaborations. This is done in the context of individual performance plans, both for the responsible staff and their superiors. If officials higher in the chain of command have no incentive to reward this behavior in their own plans, then collaborative actions are less likely to be realized.

Within TIP, senior leaders and PDs have collaboration across NSF included as part of their individual performance plans. Of course, the decision to include such incentives in the individual performance plans of other directorate staff is not within the control of TIP. Changes to the individual performance plans of other directorate officials will require the support of top NSF leaders—to whom they report—and close collaboration among leaders of those directorates.

TIP's ability to carry out its role in performing the NSF's expanded mission focus depends to a large degree on systematic collaboration between TIP and other NSF directorates, including basic research directorates and EDU. Currently, there is a lot of enthusiasm across NSF for the opportunities presented by the expanded mission and additional funding available. However, if the budget environment becomes more constrained other directorates and programs may tend to focus on their particular priorities at the expense of an enterprise-level commitment to the broader mission. Sustained collaboration across the directorates in service of the broader NSF mission will depend on mechanisms, such as individual development plans, that reward such behavior.

Recommendation 5: TIP leaders should work with the leaders of other NSF directorates to identify ways to reward collaboration across directorates on mission-critical activities through the individual performance plans of responsible officials. Also, TIP should continue its practice of setting aside funds for joint programs and funding opportunities.

Conclusion

The CHIPS and Science Act (CHIPS) authorized NSF to pursue a broader mission focus, including greater emphasis on use-inspired research, translation of research results and diversity of participation across the research enterprise. CHIPS also authorized the creation of the new Directorate for Technology, Innovation and Partnerships (TIP), to lead the implementation of this mission. TIP has been proactive in experimenting with new approaches to accomplishing this mission, working collaboratively with other NSF directorates, other federal agencies and external stakeholders including industry and non-profits.

This report is an assessment of the conditions for successful implementation, and not an evaluation of a mature program. Our research has identified that TIP leaders have implemented multiple best practices in the development of the directorate, its programs, and relationships with stakeholders and have created an organization that is poised to execute on the mission.

The successful accomplishment of this mission over time will require a sustained NSF-level effort to institutionalize these good practices into routine agency operations. For their part, TIP leaders must develop a strategy, in collaboration with leaders of other NSF directorates and offices and

senior NSF leadership that will inform the identification and prioritization of support needs (e.g., human resources, information technology, etc.) critical to the success of the mission. However, ultimate success will also require sustained support for this effort by top NSF leaders and Congress.

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Appendices

Appendix A: Panel and Study Team Member Biographies

Panel of Academy Fellows

Barry Bozeman, Panel Chair: Barry Bozeman's multifaceted career has been marked by his contributions to organizational research and public policy. Serving as the Director of the Center of Organizational Research and Design at Arizona State University, he has been a driving force behind advancements in organizational theory. His previous role as the Ander Crenshaw Chair in the Department of Public Administration and Policy at the University of Georgia highlighted his dedication to academic leadership. His tenure as a Regents' Professor of Public Policy at the Georgia Institute of Technology was characterized by his directorship of the Research Value Mapping Research Program. Bozeman's impact extended to the Maxwell School of Citizenship and Public Affairs at Syracuse University, where he directed the Center for Technology and Information Policy. Earlier, he played a key role in shaping public administration education as the Director of the Doctoral Program in Public Administration at Syracuse University. Additionally, his expertise was acknowledged through appointments as Regents' Professor and Arizona Centennial Professor of Technology Policy and Public Management at Arizona State University.

Nick Hart: Nick Hart's career reflects a dynamic engagement with evidence-informed policymaking and data advocacy. Nick is currently President & CEO of the Data Foundation, championing data-driven approaches to governance and the use of data. Previously, Hart directed the Evidence Project at the Bipartisan Policy Center from 2017 to 2019, where he remains a Fellow. As Policy and Research Director of the U.S. Commission on Evidence-Based Policymaking from 2016 to 2017, he helped formulate unanimous recommendations that became the basis of the Foundations for Evidence-Based Policymaking Act (Evidence Act). His service in government included roles as a Senior Program Examiner within the White House Office of Management and Budget, focusing on education, income maintenance, and labor programs from 2012 to 2017, as a Special Assistant from 2011 to 2012, and as a Program Examiner for natural resources programs from 2009 to 2011. Hart is an Adjunct Professor at George Washington University's Trachtenberg School of Public Policy and Public Administration in program evaluation.

Randolph Lyon: Randolph Lyon's career has been marked by a series of impactful roles in public administration and finance. As a Senior Advisor within the U.S. Small Business Administration's Office of the Administrator in 2021 and 2022, he helped SBA improve its fraud risk management framework for the agency's large pandemic-relief loan programs for small businesses. From 2015 to 2021, he served as Chief Financial Officer (CFO) and Director of Development at the National Academy of Public Administration. Prior to that, he helped establish the First Responder Network Authority, serving as FirstNet's CFO from 2013 to 2015. From 1998 to 2013, he was Chief of the Commerce Branch within the U.S. Office of Management and Budget (OMB), responsible for budgetary, management, and policy matters involving the Department of Commerce, SBA, Federal Communications Commission, and several smaller agencies. Earlier, he was a Senior Economist in OMB's Office of Economic Policy, where, among other work, he helped

establish executive branch policy on the discount rate used to assess public investment and regulatory actions and led OMB's work on tax expenditures. He served as an Adjunct Professor at Georgetown University's McCourt School of Public Policy from 1987 to 1999 and as an Assistant Director and Senior Economist at the Government Accountability Office between 1986 and 1991.

Theresa Pardo: Theresa Pardo's extensive career has been defined by her deep involvement in technology and governance research, and translation of that research to practice. Serving most recently as Associate Vice President for Research at the University at Albany, State University of New York and as Special Assistant to UAlbany's President Havidán Rodríguez, Pardo leads the development of novel interdisciplinary research and collaboration networks. Prior to assuming her role as VP for Research in 2020, Pardo directed the Center for Technology in Government at UAlbany, where she has been at the forefront of technological advancements in the public sector. During her 12 years as Director, she built a reputation for the Center as a global leader in digital government and public sector information technology, innovation, research, and practice. Pardo has impacted the field through her work as a scholar and as a professional. She has held many advisory and leadership roles, including as Past Chair of the U.S. Environmental Protection Agency's National Advisory Committee, Past-President of the International Digital Government Society, and as the first female chair of the Oman e-Government Awards Jury. Her roles as a Full Professor of Public Administration and Policy and Affiliate Faculty at the College of Emergency Preparedness, Homeland Security & Cybersecurity further exemplify her commitment to interdisciplinary and cross-sector collaboration. Her dedication to technology-driven governance is evident through her earlier roles, such as Deputy Director and Project Director at the Center for Technology in Government. Pardo's expertise was cultivated through a diverse array of roles, including positions at Siena College and Union College, where she played instrumental roles in academic computing.

Janet Weiss: Janet Weiss' distinguished career in business and public policy has featured significant contributions to the study of public and nonprofit management. As the Mary C. Bromage Collegiate Professor of Business and Professor of Public Policy at the University of Michigan, she taught and mentored generations of scholars and policymakers for nearly 40 years. During her time at the University of Michigan, Weiss also held various leadership roles, including Vice Provost for Academic Affairs from 2002 to 2015 and Dean of the Rackham Graduate School from 2005 to 2015. She had visiting appointments at Stanford, the Trachtenberg School of Public Policy and Public Affairs at George Washington University, and the McCourt School of Public Policy at Georgetown University. She was a Fellow at the Center for Advanced Study in the Behavioral Sciences in Stanford, CA, in 1994-1995. Before moving to Michigan, she was on the faculty at the School of Organization and Management and the Institution for Social and Policy Studies at Yale University. Through her research, teaching, and practice, Weiss has focused on how to improve the use of evidence, ideas, and evaluation in management of public and nonprofit organizations.

Study Team

Brenna Isman, *Director of Academy Studies***.** Brenna oversees the Academy studies, providing strategic leadership, project oversight, and subject matter expertise to the professional study teams. Before this, she was a Project Director managing projects focused on organizational

governance and management, strategic planning, and change management. Her research engagements have included working with the National Aeronautics and Space Administration, the Environmental Protection Agency, the Social Security Administration, the Department of Veterans Affairs, and multiple regulatory and Inspector General offices. Before joining the Academy, Brenna was a Senior Consultant for the Ambit Group and a Consultant with Mercer Human Resource Consulting. Brenna holds a Master of Business Administration (MBA) from American University and a Bachelor of Science (BS) in Human Resource Management from the University of Delaware.

Jonathan Tucker, *Project Director*. Jonathan has served as a Project Director and as a Senior Research Analyst for several Academy projects. His areas of expertise include strategic planning, organizational design, change management, and science and technology/innovation policy. Mr. Tucker holds a PhD in Public Policy from George Mason University, an MS in Science and Technology Studies from Rensselaer Polytechnic Institute, and a BA from New College of Florida.

Mark Hertko, *Deputy Project Director*. Mark has served as a Project Director and Senior Analyst on several Academy projects, including the Federal Bureau of Investigation; Department of Homeland Security—US Coast Guard; Department of Interior—National Park Service; Environmental Protection Agency's National Center for Environmental Innovation, Office of Environmental Information, Office of Water, Office of Environmental Justice, Office of Air and Radiation; Corporation for National and Community Service; and Department of Energy's Office of Energy Efficiency and Renewable Energy. Mark holds a BA from The Monmouth College in Biology, an MA in Environmental Science from the University of Illinois Springfield, and an MST in Education from Pace University.

Robert Goldenkoff, *Senior Advisor*. Robert has over 30 years of experience in federal program evaluation and organizational transformation with the U.S. Government Accountability Office. He retired from GAO in January 2020 as a Director on GAO's Strategic Issues team where he led a portfolio of work focused on strengthening federal human capital management and improving the cost-effectiveness of the federal statistical system. His work resulted in tens of millions of dollars in financial savings, and dozens of program improvements. Mr. Goldenkoff was also an adjunct faculty member at GAO's Learning Center where he taught classes on congressional testimony, congressional relations, and performance auditing. Mr. Goldenkoff received his B.A. (political science) and Master of Public Administration degrees from the George Washington University.

Chloe Yang, *Senior Research Analyst*. Chloe is a Senior Research Analyst at the Academy. Since joining the Academy in 2009, she has worked on projects with a range of federal and state agencies, including the Office of Personnel Management, the National Oceanic and Atmospheric Administration, the State Chamber of Oklahoma, and the Bureau of Transportation Statistics. Before joining the Academy, Ms. Yang was the research intern at the Foundation Environmental Security and Sustainability. She has also worked as an intern at the Woodrow Wilson Center for Scholars and a research assistant at George Mason University (GMU). Ms. Yang graduated from GMU with a Master's in Public Administration. She also holds a bachelor's degree in Financial Management from the Renmin University of China.

Sarah Jacobo, *Research Associate*. Sarah has served on studies for different federal agencies, including work for the U.S. Department of Agriculture and the National Science Foundation. Sarah earned a Master of Public Policy and a BA in Government and Politics, and Public Policy from the University of Maryland, College Park. Before joining the Academy, Sarah was an intern with the Academy's Study Team and worked on the Cybersecurity Workforce Study for the Cybersecurity and Infrastructure Security Agency.

Nadia Faour, *Research Associate*. Nadia Faour joined the Academy in March 2023 as a Research Associate. She serves on studies for the National Science Foundation and the United States Agency for International Development Office of Inspector General. Ms. Faour graduated from George Mason University with a BA in Global Affairs concentrating in global inequalities and responses.

Appendix B: List of Interviewees

National Science Foundation

Technology, Innovation and Partnerships Directorate

- **Peter Atherton,** POSE Program Director, Translational Impacts
- **Tess DeBlanc-Knowles,** Staff Associate for Technology Policy and Strategy
- **Erwin Gianchandani,** Assistant Director
- **Barry Johnson,** Division Director, Translational Impacts
- **Yuen Lau,** Staff Associate for Evaluation and Assessment
- **Douglas Maughan,** Convergence Accelerator Section Head, Innovation and Technology Ecosystems
- **Nina Maung-Gaona,** ExLENT Program Director, Innovation and Technology Ecosystems
- **Kerstin Mukerji,** Staff Associate for Strategic Engagements
- **Thyaga Nandagopal,** Division Director, Innovation and Technology Ecosystems
- **Graciela Narcho,** Deputy Assistant Director
- **Dmitri Perkins,** Regional Innovation Engines Lead Program Director, Innovation and Technology Ecosystems
- **Benaiah Schrag,** America's Seed Fund Program Director, Translational Impacts
- **Rebecca Shearman,** EPIIC Program Director, Innovation and Technology Ecosystems
- **Ruth Shuman,** I-Corps Program Director, Translational Impacts
- **Jesus Soriano Molla,** Partnerships for Innovation Program Director, Translational Impacts
- **Grace Yuan,** Staff Associate for Data and Analytics

NSF Officials

- **Dorothy Aronson,** CIO, Office of the Director
- **Linda Blevins,** Senior Advisor, Office of Integrative Studies
- **Janis Coughlin-Piester,** CFO, Office of Budget, Finance and Award Management
- **Christina Freyman,** Deputy Division Director (Acting), NCSES
- **Wonzie Gardner,** Office Head, Office of Information and Resource Management
- **Dario Gil,** Member, National Science Board
- **Amanda Hallberg Greenwell,** Office Head, Office of Legislative and Public Affairs
- **Alicia Knoedler,** Office Head, Office of Integrative Studies
- **Karen Marrongelle,** COO, Office of the Director
- **Sethuraman Panchanathan,** Director, Office of the Director
- **Sandra Richardson,** Section Head, EPSCoR
- **Erika Rissi,** Chief Evaluation Officer and Section Head (Acting), Evaluation and Assessment Capability, Office of Integrative Studies

NSF Directorates Staff

- **Nina Amla,** Senior Science Advisor, Computer and Information Science and Engineering Directorate
- **Sylvia Butterfield,** Acting Assistant Director, Social, Behavioral and Economic Sciences Directorate
- **Mary Crowe,** Program Director, STEM Education Directorate
- **Theresa Good,** Acting Deputy Assistant Director, Biological Sciences Directorate
- **Alexandra Isern,** Assistant Director, Geosciences Directorate
- **Sean Jones,** Assistant Director, Math and Physical Sciences Directorate
- **Susan Margulies,** Assistant Director, Engineering Directorate
- **Margaret Martonosi,** Assistant Director, Computer and Information Science and Engineering Directorate
- **James Moore III,** Assistant Director, STEM Education Directorate

Congressional Staff

- **Sara Barber,** Majority Staff, House Committee on Science, Space, and Technology
- **Liz Barczak,** Majority Staff, CJS Subcommittee, House Committee on Appropriations
- **Richard-Duane Chambers,** Majority Staff, Senate Committee on Commerce, Science, and Transportation
- **Nora Faye,** Minority Staff, CJS Subcommittee, House Committee on Appropriations
- **Hannah Hagen,** Minority Staff, Senate Committee on Commerce, Science, and Technology
- **Cate Johnson,** Minority Staff, House Committee on Science, Space, and Technology
- **Julia Pan,** Majority Staff, Senate Committee on Commerce, Science, and Transportation
- **Jonny Pellish,** Majority Staff, Senate Committee on Commerce, Science, and Transportation
- **Victoria Rubin,** Minority Staff, Senate Committee on Commerce, Science, and Transportation
- **Blaise Sheridan,** Majority Staff, CJS Subcommittee, Senate Committee on Appropriations
- **Dahlia Sokolov,** Majority Staff, House Committee on Science, Space, and Technology
- **Emma Stohlman,** Majority Staff, Senate Committee on Commerce, Science, and Transportation
- **Kevin Wheeler,** Minority Staff, CJS Subcommittee, Senate Committee on Appropriations

Federal Stakeholders

- **Daniel Goroff,** Science and Society Deputy Director, Office of Science and Technology Policy
- **Dan Massey,** Director, 5G Operate Through, Department of Defense
- **Yi Pei,** Program Examiner, Office of Management and Budget

- **Paul Shawcross,** Chief, Science and Space Programs Branch, Office of Management and Budget
- **Eric Smith,** Director, Office of Innovation and Entrepreneurship, Economic Development Administration

Other Stakeholders

- **Dan Correa,** CEO, Federation of American Scientists
- **Jonathan Fay,** Great Lakes I-Corps Hub Director, University of Michigan
- **Justin Field,** Senior Vice President of Government Affairs, National Venture Capital Association
- **Teddy Ivanitzki,** Director, Fellowship and Research Opportunities, American Society for Engineering Education
- **Tom Kalil,** Chief Innovation Officer, Schmidt Futures
- **Dan Kuntiz,** Mid-Atlantic I-Corps Hub Director, University of Maryland
- **Jason Oxman,** President and CEO, Information Technology Industry Council (ITI)
- **Caleb Watney,** co-founder and co-CEO, Institute for Progress

Subject Matter Experts

- **Robert Atkinson,** President, Information Technology and Innovation Foundation
- **Mahmud Farooque,** Associate Director, Consortium for Science, Policy & Outcomes
- **Mary Feeney*,** Science of Science: Discovery, Communication and Impact (SoS:DCI) Program Director, Social, Behavioral and Economic Science Directorate, National Science Foundation
- **Michelle Govani,** Director, Strategy and Partnerships, Office of Applied Innovation, Arizona State University, Consortium for Science, Policy & Outcomes
- **David Guston,** Associate Vice Provost and Professor, Consortium for Science, Policy & Outcomes
- **Nicholas Weller,** Postdoctoral Research Associate, School for the Future of Innovation in Society, Arizona State University, Consortium for Science, Policy & Outcomes
- **Deborah Wince-Smith,** President and CEO, Council on Competitiveness

*Academy Fellow

Appendix C: TIP Division and Program Level Budget Breakdowns

Table 7. TIP Division Level Budget Breakdown (Dollars in Millions)

	FY21	FY22		FY23		FY24
	Actuals	**Request**	**Actual**	**Request**	**Estimate w/ Supplemental**	**Request**
TF		150.00	-	145.00	129.80	196.80
ITE	74.89	335.00	78.22	265.00	349.00	490.00
TI	294.11	329.87	334.86	419.00	401.00	488.64
SPH		50.00	-	50.87	0.20	10.19
Total	369.01	864.87	413.09	879.87	880.00	1,185.63

Source: President's FY 2022-24 Budget Requests

Table 8. TIP Program Level Budget Breakdown (Dollars in Millions)[39]

	FY21	FY22		FY23		FY24
	Actuals	**Request**	**Actuals**	**Request**	**Estimate**	**Request**
Convergence Accelerator	50.70	70.00	64.98	70.00	70.00	100.00
PFI	22.32	30.00	30.04	30.00	30.00	30.00
I-Corps	39.02	40.00	39.93	40.00	50.00	50.00
SBIR/STTR	232.28	274.64	235.68	283.06	266.54	304.18
Accelerating Public & Private Partnerships		50.00	-	50.87	0.20	10.19
Assessment of S&T Investments			4.00	40.00	20.00	25.00
Entrepreneurial Fellowships (Activate)		20.00	2.24	25.00	10.00	10.00
Testbeds						106.00
ART					45.00	45.00
ExLENT					20.00	50.00
POSE			9.29	-	27.80	35.00
NSF Engines		200.00	-	200.00	200.00	300.00

Source: President's FY 2022-24 Budget Requests

[39] The table does not contain all active TIP programs; only programs and initiatives stated in the budget request are listed. Convergence Accelerator, PFI, I-Corps, and SBIR/STTR have FY21 actuals because they are programs that predate TIP's existence and were moved into the TIP Directorate when it was formed.

Appendix D: TIP Program Summaries

Accelerating Research Translation (ART) The ART program supports academic institutions in accelerating and expanding their translational research initiatives to deliver impactful products, services, and solutions. The main objectives of this program are to strengthen the foundation and capacity for translational research at U.S. Institutions of Higher Education (IHEs) and to strengthen their role in regional innovation ecosystems. ART supports IHEs work on building the necessary infrastructure to boost the overall institutional capacity to accelerate and scale translation of fundamental research outcomes into practice by supporting the development of a range of activities essential for this activity. Additionally, ART aims to effectively train postdoctoral researchers and graduate students in translational research.

America's Seed Fund (NSF SBIR/STTR) The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) are programs that focus on supporting small domestic businesses/ startups to engage in Federal Research/Research and Development (R/R&D). These programs give these businesses an opportunity to explore their potential and provide incentives to profit from commercialization. The programs provide funding for the research and development of deep technologies, which are based on discoveries in fundamental science and engineering. SBIR/STTR bridges the gap between the performance of basic science and the commercialization of resulting innovations.

Assessing and Predicting Technology Outcomes (APTO) The APTO program provides funding for a group of initiatives that collaborate to assist each other's research and development (R&D) efforts on technology outcome models. These models appropriately describe three types of technology outcomes: "technology capabilities, technology production, and technology use." This program includes the development of prediction models which are generalizable across multiple technology areas. These models forecast technological outcomes for both the future and the past. In order to help decision makers plan and maximize expenditures for enhancing long-term U.S. competitiveness into the future, the effort aims to assist in measuring and evaluating the efficacy of U.S. R&D investments.

Convergence Accelerator The NSF Convergence Accelerator builds upon fundamental research and discovery to accelerate solutions that solve societal challenges. The program achieves this by providing funding to teams that utilize convergence research and innovation on these issues. The program is centered on a convergent research approach that "is use-inspired and supplication-oriented, is fed by basic research and discovery, integrates teams from industry, academia, nonprofits, governments and other communities of practice, and offers intensive hands-on education and mentorship to participants."[40] The program offers researchers a chance to expedite their research into solutions that have societal impacts.

Enabling Partnerships to Increase Innovation Capacity (EPIIC) The EPIIC Program supports the broadening of inclusive innovation ecosystems through capacity-building efforts at institutions of higher education with limited research capacity. Through the support of capacity-building efforts, EPPIIC strives to establish a more inclusive environment for traditionally

[40] National Science Foundation. NSF Convergence Accelerator Phase I and II Program Solicitation NSF 20-565. Alexandria, VA, 2020. https://www.nsf.gov/pubs/2020/nsf20565/nsf20565.htm.

underrepresented demographics of scientists and researchers. The program encourages all Americans to have an active role in the development of fundamental research. EPIIC aims to create an equitable research environment between Minority Serving Institutions (MSIs), Predominantly Undergraduate Institutions (PUIs), two-year institutions with limited or no research capacity, and teams who are currently operating under NSF Engines program funding opportunities.

Entrepreneurial Fellowships/Activate This program is a fellowship that provides research facilities and essential funding to fellows with the aim of transforming basic research into having a market impact. Fellows are selected based on their research's ability to transform aspects of certain industries/ infrastructure. This program can develop research breakthroughs into new products and services that have societal and economic benefits. Fellows receive an allocated amount of funding as well as direct support for their efforts.

Experiential Learning for Emerging and Novel Technologies (ExLENT) The ExLENT Program, which is located both in TIP and EDU NSF directorates, aims to support experiential learning opportunities for people from a diverse range of educational and professional backgrounds. This initiative seeks to increase interest, awareness, and access to STEM fields of study for traditionally underrepresented individuals. The ExLENT program supports initiatives which highlight diverse individuals with crucial skills that are necessary for emerging technology fields. In addition to introducing many to particular STEM and emerging technology fields, ExLENT will prepare these individuals for a career in STEM. The key goals of this program are "(1) expand access to career-enhancing experiential learning opportunities for a broader, more diverse population, including adult learners interested in re-skilling and/or upskilling (e.g., those who face or who have faced significant barriers to accessing a formal STEM education); (2) promote cross sector partnerships between organizations in emerging technology fields and those with expertise in workforce development; and (3) develop a workforce aligned with regional economies based on emerging technologies across the Nation, in alignment with the mission of the TIP Directorate."

Innovation Corps (I-Corps™) I-Corps is a national and regional curriculum-based program to train scientists in 2- and 4-year institutions of higher learning about how to engage in the research-to-commercialization pathway for "deep technologies." The National I-Corps program is an intensive 7-week training that is competitively awarded to research teams. Each team is composed of an Entrepreneurial Lead, Technical Lead and Industrial Mentor. The Regional I-Corps program extends the reach of this program cross-country. This program is supported by a regional set of partnership hubs. Each hub is established with at least 7 partners and is required to add at least one additional partner on an annual basis. Taken together, the hubs form the National Innovation Network (NIN) which is the backbone of the I-Corps program. The hubs provide an abbreviated National I-Corps curriculum to teams of "local" researchers that apply to the program. The hub partners provide training, instructors, and commit to conducting research on innovation ecosystems to strengthen the partnership and curriculum.

Partnerships for Innovation (PFI) The PFI program offers researchers an opportunity to gain market insights, launch a commercial application or facilitate industry adoption. The program helps researchers translate basic research into technologies and spurs university spinoff

companies. PFI has five broad goals, as set forth by the American Innovation and Competitiveness Act of 2017 "(1) identifying and supporting NSF-sponsored research and technologies that have the potential for accelerated commercialization; (2) supporting prior or current NSF-sponsored investigators, institutions of higher education, and non-profit organizations that partner with an institution of higher education in undertaking proof-of-concept work, including the development of technology prototypes that are derived from NSF-sponsored research and have a potential market value; (3) promoting sustainable partnerships between NSF-funded institutions, industry, and other organizations within academia and the private sector with the purpose of accelerating the transfer of technology; (4) developing multi-disciplinary innovation ecosystems which involve and are responsive to the specific needs of academia and industry; (5) providing professional development, mentoring, and advice in entrepreneurship, project management, and technology and business development to innovators"

Pathways to Enable Open-Source Ecosystems (POSE) The POSE program aims to utilize open-source development for the creation of new technology solutions to societal issues. POSE supports the transition from open-source research artifacts to Open-Source Ecosystems. A self-sustaining open-source ecosystem (OSE) is built around an open-source product that has the potential to be widely adopted. It consists of a leadership team, a managing organization with a clear governance structure and distributed development model, a strong community of outside intellectual content developers, and a large user base from academia, business, and government. The POSE initiative aims to increase the number of academics and innovators who work on OSE projects and contribute to them, as well as to open up new avenues for the creation of OSEs with significant societal benefits.

Proto-Open Knowledge Network (Proto-OKN) The Proto-Open Knowledge Network is an interconnected network of knowledge graphs supporting a broad variety of application domains. This program can be crucial to the advancement of artificial intelligence (AI) and AI-powered solutions through open-access to shared information. Using ontologies and ontology alignment, knowledge graphs—which reflect the connections between real-world entities—providing a powerful method for organizing, describing, integrating, reusing, and accessing data from many structured and unstructured sources. Numerous consumer applications, like online search, e-commerce, banking, medicine development, advertising, etc., are currently powered by private-sector investments in knowledge graphs. This program seeks to "empower government and non-government users — fueling evidence-based policymaking, continued strong economic growth, game-changing scientific breakthroughs, while addressing complex societal challenges from climate change to social equity."[41]

Regional Innovation Engines (NSF Engines) The Regional Innovation Engines program aims to create innovation ecosystems across the country to accelerate emerging technology fields, drive the economy, address societal challenges, and contribute to national competitiveness. Each regional Engine focuses on addressing a specific aspect of a societal and/or economic issue which is a particular interest in that specific Engines defined "region of interest." The program is interested in establishing economic growth and new business opportunities in areas of the country

[41] National Science Foundation. Building the Prototype Open Knowledge Network (Proto-OKN) Program Solicitation NSF 23-571. Alexandria, VA, 2023. https://www.nsf.gov/pubs/2023/nsf23571/nsf23571.htm.

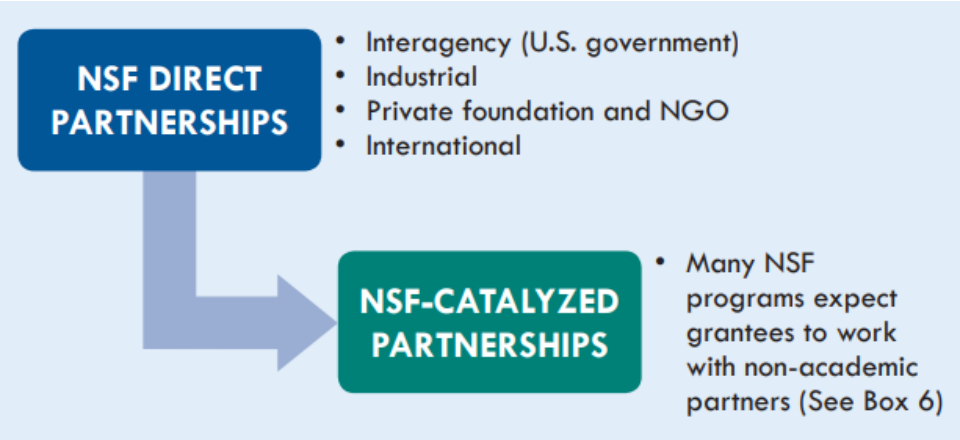
that have not traditionally contributed to fundamental research in the past. In addition to this, NSF Engines emphasizes the importance of the transition of fundamental research to research-based solutions.

Visionary Interdisciplinary Teams Advancing Learning (VITAL) This program focuses on empowering research teams to develop new learning technologies for K-12 students. The innovative technologies developed should focus on integrating recent science and engineering discoveries with educational curriculums and training. The program aims to increase equitably improve educational outcomes and engagement in education for a broader range of students.

Appendix E: NSF Partnerships Definition

One of TIP's goals is to use partnerships to advance innovation and translation. NSF's partnerships are divided into two types, direct partnerships and catalyzed (indirect) partnerships.[42]

Figure 5. Schematic of NSF Partnerships



Source: NSF Partnerships: Landscape Study

The NSF direct partnerships are relationships that the agency engages with through its personnel, and they are typically formalized through some signed agreement, such as a memorandum of understanding (MOU). Direct partnerships can be with other agencies, industry, public and private organizations, and international entities. NSF engages in informal partnering as well for workshops, logistics, or other small coordination efforts.

Catalyzed (indirect) partnerships are partnerships that are between an awardee and their partners. The NSF award catalyzes the awardee's creation of a partnership with other organizations. The relationship is typically developed because it is encouraged or required by the NSF solicitation. The Foundation engages with the principal awardee but does not directly engage in its awardee's partnerships.

Internal NSF partnerships are referred to as "collaborations" because of how closely the staff members work together both formally and informally. NSF has numerous working groups, staff meetings, and other ways to facilitate cross-Foundation communication and collaboration.

[42] National Science Foundation. NSF Partnerships: Landscape Study. Alexandria, VA, 2020. https://www.nsf.gov/pubs/2021/nsf21201/nsf21201.pdf.

Appendix F: Preexisting Program Reporting Requirements

Convergence Accelerator

To enable effective oversight of its investment and fulfill its monitoring and management responsibilities, NSF needs 1) current and up-to date administrative data, 2) characteristics of the teams funded by the CA Program, and 3) structured and unstructured data on the immediate, intermediate, short- and long-term outputs and outcomes of the Program.

These data are collected through a panel of 5 surveys:

1. **Group Entrance Survey** – designed to collect information on Team Characteristics, Partnership/Engagement, Project Progress/Outcome, and Impact Assessment
2. I**ndividual Entrance Survey –** designed to collect information on Participant Characteristics, Team Dynamics/Engagement, Project Aspirations, and Impact Assessment
3. **Mid-year Survey** – designed to get a pulse on the Participants' Program Experience/Satisfaction, Team Collaboration/Relationship, Project Outcomes, and Impact Assessment. This survey is an identical version of the Exit Survey.
4. **Exit Survey** – designed and specifically tailored to collect information from the participants on Program Experience/Satisfaction, Team Collaboration/Relationship, Project Outcomes, and Impact Assessment.
5. **Coaching Feedback Survey** – designed to collect information from Participants on the engagement, effectiveness, and experience when working with the coaching staff who are contractors to the NSF CA Program.

The **Entrance Surveys (1 & 2)** are focused on seeking information from the participants and understanding the following:

- Did you encounter any barriers in the application process?
- What specific goals do you have for the development of your solution?
- Who are your anticipated users?
- How do you believe your solution will affect the users' lives positively?
- What are your partnership goals for Phase 1?

The **Mid-year and Exit Surveys (3 & 4)** are focused on the following themes:

- Team Functioning
    - Perception of successful team functioning
- Organizational Sustainability
    - Whether the team currently Has a Sustainability Plan
    - Perceptions of Success in terms of sustainability
- Product Development and User Testing
    - Perceptions of *current* Project Maturity vs that *when Starting CA*
    - Perceptions of current Technology Readiness Level vs that *when Starting CA*
    - Perceptions of product success
- Partnerships

    - Perceptions of partnership success
- Impact and Outcomes
    - Predicted impact of product on end users
    - Number of patents applied and number of patents granted
    - Number of partners gained
- Convergence
    - Team convergence measure
        - Here, *Convergence* is defined as a project being deeply integrated with diverse expertise, sectors, and disciplines. The notion of *Convergence* is then measured through a series of 3 questionnaire items:
            - The participants' perceptions of progression (in terms of convergence) when comparing to the beginning of the project.
            - Track integration facilitating and enabling team convergence
                - Whether "track integration" contributed to the convergence of the project
                - If applicable, to what extent were "track integration" contributed to such convergence
            - Perceptions of track integration's value
- CA and the Ecosystem
    - *CA Program impact compared to other funding opportunities;* there were 2 questionnaire items pertaining to this measure:
        - The participants' perception on how the CA Program has impacted their projects compared to other opportunities they might have had in its place
        - Open response question on elaborating on the selected choice
            - Here, we would like to know and solicit from the survey respondents: 1) whether the funding provided by CA Program makes an impact on the project, 2) whether these participants encountered such unique funding opportunity and/or received such funding in the past, 3) if 'yes' to both, how are the funding scope and conditions between the CA funding mechanism and the other funding opportunities are alike and differed, 4) if 'no' to both, what are the missing gaps of the CA funding mechanism and other funding opportunities.
    - Whether the participation of the program led to an increase in interest in Entrepreneurship

The **Coaching Survey (5)** is focused on the following:

- How well is each team working together?
- Are there activities that will help NSF support each team?
- How receptive is each team to feedback from you and other coaches?
- How effectively are they incorporating feedback?
- Is each team making progress towards long-term sustainability?

Innovation Corps (I-Corps)

Metrics/Indicators for the National I-Corps Teams Program

NSF is directed—under the AICA—to collect data and information about the characteristics, outputs, and outcomes from the I-Corps Teams as well as individuals funded by the I-Corps Program. The collection of this information will enable the reporting on the four themes as outlined in the biennial I-Corps Report to Congress:

1. Training an Entrepreneurial Workforce
2. Translating Technology
3. Enabling Economic Impact
4. Nurturing an Innovation Ecosystem

The metrics for each of the four themes are as follows:

1. Training an Entrepreneurial Workforce
    a. Number of individuals participated in the Program
    b. Participation from women
    c. Participation from underrepresented groups*
    d. Number of Entrepreneurial Leads trained
        i. Women
        ii. Underrepresented groups
        iii. Job status at the time of training
            1. Graduate student
            2. Post-doc scholar
            3. Undergraduate student
            4. Startup management
            5. Others
    e. Source of Teams
        i. I-Corps Nodes/Sites/Hubs
        ii. Other Federal agencies
        iii. SBIR/STTR Programs
        iv. PFI Program
        v. International Partnerships (etc)
2. Translating Technology
    a. Number of Participating I-Corps Teams
        i. As each I-Corps team focuses on the evaluation of the market opportunity of a specific technology under development in a research laboratory, the number of teams is a measure of the number of new technologies evaluated for commercial potential.
        ii. I-Corps projects encompass a wide range of technologies and represent many categories of cutting-edge science and engineering research. NSF does not have a technology topic preference but does encourage applications from researchers with NSF or other research awards in science and engineering. The largest NSF technology topic areas represented in the current reporting period include: Biomedical

Engineering and Life Sciences, Information Technology, Advanced Manufacturing and Materials, and Environmental Technology.

3. Enabling Economic Impact
    a. Number of Teams linked to startups
    b. Number of startups formed
    c. Subsequent funding raised
    d. Number of Merger & Acquisition
    e. Source of Subsequent fundings obtained by startups
        i. Public Funding
        ii. Private Funding
4. Nurturing an Innovation Ecosystem -- The National Innovation Network (NIN) historically had been a tightly connected organization of Nodes and Sites that made up NSF I-Corps' regional training programs. In FY 2021-2022, NSF reorganized the NIN to consist of ten (10) new I-Corps Hubs, that now serve as the operational backbone of the NSF regional program and NIN. The NSF I-Corps Hubs expand the network of universities and collaborators as well as build and sustain a diverse and inclusive innovation ecosystem throughout the U.S. Each NSF I-Corps Hub comprises a regional alliance of at least eight universities. The current NSF I-Corps Hubs represent 94 academic institutions in 40 states and the District of Columbia. In order to cover the entire geographic diversity of the U.S., NSF plans to invest in additional I-Corps Hubs, subject to the availability of funds.

Additionally, we also collect metrics that we track and use for internal evaluation as part of the assessment on the participation satisfaction (in the form of a course survey) and program effectiveness. These metrics are organized by the following facets:

1. I-Corps Instructors
2. Mode of instructional delivery
3. Relevancy and applicability of the course materials on their team's technological development/pathway

Metrics/Indicators for the I-Corps Hubs Program

The NSF I-Corps Hubs have four strategic goals within the NIN:

- Training: Deliver regional I-Corps training at partner institutions and provide instructors for National I-Corps training.
- Expansion: Identify, recruit, and support teams for regional I-Corps training and recommend teams for the National I-Corps program. Grow the Hub by identifying new member institutions.
- Evaluation, Assessment, & Research: Collect and analyze data from participants in the regional program to measure regional economic impact, evaluate and improve on the Hub's performance, and conduct entrepreneurial research.
- Diversity, Equity & Inclusion: The NIN is expected to be diverse and inclusive in all aspects – including research disciplines, participants, personnel, institutions, tools, programs, abilities, and geographic locations.

To assess these goals, NSF asks each Hub to report on administrative data about the Hub (Hub structure, personnel working at the Hub), show records of cohorts trained, and records of participation on both team-level and individual-level. The Hubs are also asked to track the outcomes of each team that went through the Hub.

Outcomes of the team include:

1. Advancement to the I-Corps National Program:
    a. Has the team applied or been accepted into the NSF National I-Corps Program? If accepted, the Team Number and the Name of the Cohort in the NSF I-Corps National Program
2. Startup Formation
    a. Name of the startup companies founded by the Team (the data needs to be verified with the U.S. Security and Exchange Commission database)
3. Private Capital Funding
    a. Subsequent private funding received by the teams after their participation of the I-Corps Program (data obtained from a third-party subscription database). Each transaction is dated, funding amount recorded, and funding type categorized by:
        i. Venture capital,
        ii. Angel or Individual Investor, or
        iii. Private Industry, Corporate Funding, or Other
4. Public Funding
    a. Subsequent public funding received by the teams after their participation of the I-Corps Program (data obtained from USASpending.gov). Each transaction is dated, funding amount recorded, and funding type categorized by:
        i. SBIR/STTR Program (in any Federal agency),
        ii. Other federal funding [non-SBIR/STTR], or
        iii. State funding
5. Exit Activities of startups linked to teams participating in the regional program:
    a. Mergers
    b. Acquisitions
    c. IPOs

Data collection efforts began on January 2023.

Partnerships for Innovation (PFI)

The annual and final reports must describe the concrete efforts made, and results obtained towards realizing the commercialization potential of the funded technology. The final report must describe progress in the following areas:

- Patent applications
- Patents granted and derived or both
- Licensing agreements
- Company formation
- Royalties realized
- SBIR/STTR proposal submission (with agency name and date submitted)

- For PFI-Research Partnerships awards, outcomes of collaboration with Industrial Partners
- Third party financing
- Learning outcomes of entrepreneurial education training of students and postdoctoral researchers
- Enhancing career trajectories of team members
- Work conducted under the I-Corps Teams program, the progress and learning made by the team in the reporting period, the outcomes of the work, and the project's vision. It should articulate the customer segments explored, what pivots were made and how the team sees their value proposition and the rest of the business model.

Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR)

Administrative data (cover sheet data at the time of proposal submission)

The NSF SBIR/STTR programs are Congressionally mandated. By investing Federal research and development funds into startups businesses, NSF hopes to stimulate the creation of novel products, services, and solutions in the private sector, strengthen the role of small business in meeting Federal research and development needs, increase the commercial application of Federally-supported research results, develop and increase the US workforce, especially by fostering and encouraging participation by socially- and economically-disadvantaged and women-owned small businesses, and build a strong national economy.

To that end, small businesses who apply for the SBIR/STTR grant are asked to provide the following information at the time of their applications:

- Whether it is a small business as defined in the solicitation
- Whether the small business is qualified as a socially and economically disadvantaged small businesses
- Whether the small business is qualified as women-owned business
- Whether two thirds of the research will be performed at the firm listed on the application
- Year the firm was founded
- Number of employees in the firm (average in the last 12 months, and currently)

Metrics/Indicators for Evaluation

Both the NSF SBIR and NSF STTR programs have two phases: Phase I and Phase II. Phase I is a 6-12 month experimental or theoretical investigation that allows the awardees to determine the scientific, technical, and commercial merit of the idea or concept. Phase II further develops the proposed concept, building on the feasibility of the project undertaken in Phase I, with a goal of working toward the commercial launch of the new product, process, or service being developed. To enable effective oversight of its investment and fulfill its monitoring and management responsibilities, the Programs need 1) current and up-to date administrative information from the startup companies funded by the NSF SBIR/STTR programs at the time of their Phase I awards, and 2) standardized data on the immediate, intermediate, short- and long-term outcomes of the programs.

The initial data collection effort focuses on the first item, which is to request and solicit self-reported administrative records from these startup companies. Information pertaining to the structures, characteristics, and features of these startup companies, as well as attributes on the corresponding founder(s) of these startups were requested. As such, two separate survey instruments have been designed accordingly to properly capture the characteristics, traits, and features of both startup businesses and founder(s)/awardee(s) that the NSF SBIR/STTR programs funded.

Some of the metrics from the Business Survey include:

- Company characteristics:
    - Geography (company location)
    - Number of full-time equivalent employees
- Company structure
    - Ownership status and corporate structure
    - Funding level & funding sources
- Company features:
    - Research lineage
    - University connections/spinout
    - Technology focus (by NAICS code)
    - Technology Readiness Level
    - Licensing activities

Some of the metrics from the Founder Survey include:

- Founder characteristics, which include:
    - Highest education obtained
    - Demographics
    - University affiliation
    - Pre-company employment
    - Entrepreneurial experience
    - Current engagement and involvement level with the startup

For the second item: immediate, intermediate, short- and long-term outcomes of the programs. Future data collection efforts are underway.

The long-term outcome that the Programs aim to accomplish is to: Accelerate Technology Translation and Development (in the key tech areas and to address national challenges as outlined in the CHIPS and Science Act).

The long-term outcome can be unpacked into two components and subcomponents:

1. Advance U.S. competitiveness
    a. Economic advancement
    b. Social advancement
    c. Sustainability advancement
2. Drive Translation of Technology

These components and sub-components can be further mapped out to intermediate outcomes, then to short term outcomes:

1. Economic advancement (long term)
    a. Income (intermediate)
        i. Amount of follow-on (non-governmental) funding raised by these startups (short term)
        ii. Amount of revenues generated from products and/or services created by these startups
    b. Employment
        i. Number of jobs generated at these startups, by diversity and type
    c. Productivity
2. Social advancement
    a. Knowledge translation
        i. # of NSF PIs that take advantage of opportunities for translational activities
    b. Technology transition
        i. # of NSF sponsorees that pursue translational career pathways
    c. Diverse and quality workforce
        i. # and diversity of people equipped with different skills and innovation mindsets as a result of NSF support
3. Sustainability advancement
    a. Responsible development to achieve ecological goals and minimize environmental impacts
4. Drive translation of technology
    a. Widespread consumer adoption (long term)
        i. Adoption Readiness Level of products/services (intermediate term)
        ii. # and geographical diversity of translational activities (short term)
            1. Tech transfer activities from university (patent applications, patents, licensing, etc) (immediate term)
        iii. # of patents
            1. # of patent applications
        iv. # of IPOs
        v. # of mergers and acquisitions
        vi. # other licensing activities

Appendix G: NSF Budget and FTE Allocations Breakdown

Table 9. NSF Directorate Budget Breakdown FY2021-24 (Dollars in Millions)

	FY21		FY22		FY23		FY24
Directorate	Budget Request	Actual	Budget Request	Actual	Budget Request	Estimated Actual	Budget Request
BIO	$704.95	$817.74	$948.51	$831.62	$970.23	$856.98	$972.41
CISE	1,062.40	1,007.13	1,116.06	1,014.72	1,150.78	1,050.57	1,172.14
EDU	930.93	968.66	1,287.27	1,006.00	1,377.18	1,154.00	1,496.18
ENG	909.78	764.43	916.79	774.53	940.28	808.80	970.00
GEO	836.61	1,004.27	1,194.92	1,580.40	1,239.05	1,613.31	1,801.98
MPS	1,448.32	1,593.31	1,690.74	1,615.26	1,746.85	1,685.84	1,835.79
SBE	246.84	282.11	319.66	285.86	330.21	313.20	360.60
TIP	-	369.01	864.87	413.09	879.87	880.00	1,185.63

Source: President's FY2021-24 Budget Requests

Table 10. NSF Organizational Excellence Funding FY2021-24 (Dollars in Millions)[43]

	FY21	**FY22**	**FY23**	**FY24**
Budget Request	$525.06	$700.19	$719.06	$802.53
Actual	$565.33	$640.71	$733.40	TBD

Source: President's FY2021-24 Budget Request

[43] According to the budget request, "[t]he Organizational Excellence portfolio underpins the agency's programmatic activities and is critical to the accomplishment of NSF's mission…". The functions in Organizational Excellence are the same functions the Study Team refers to as mission support.

Table 11. NSF FTE and IPA Allocations FY2021-23

	FY21		FY22		FY23	
Directorate/ Office	Permanent **FTE** Allocation	Permanent **IPA** Allocation	Permanent **FTE** Allocation	Permanent **IPA** Allocation	Permanent **FTE** Allocation	Permanent **IPA** Allocation
BFA	160	2.0	160	2.0	169	2.0
BIO	120	22.0	120	22.0	122	22.0
CISE	91	38.0	91	38.0	96	41.0
EHR/EDU	132	30.0	132	30.0	141	36.0
ENG	122	33.0	99	33.0	105	34.0
GEO	161	29.0	161	29.0	163	37.0
IRM	183	0.0	183	0.0	204	0.0
MPS	140	28.0	140	28.0	146	37.0
OD	145	11.0	139	11.0	197	20.0
SBE	112	14.0	112	14.0	118	14.0
TIP			40	9.0	54	38.8
Total (without Students)	**1,366**	**207.0**	**1,377**	**216.0**	**1,515**	**281.8**
INTERNS	35	0.0	35	24.5	35	0.0
Total Students	**35**	**0.0**	**35**	**24.5**	**35**	**0.0**
Total	**1,401**	**207.0**	**1,412**	**240.5**	**1,550**	**281.8**

Source: TIP Office of the Assistant Director

Appendix H: Change Management Key Success Indicators

Best Practices / Lessons Learned	Transforming Organizations* (Abramson/Lawrence)	Heart of Change* (Kotter/Cohen)	Implementation Steps to Assist Mergers and Organizational Transformations* (GAO July 2003)
	Select the right person	Create a sense of urgency so that people start telling each other "Let's go, we need to change things!"	Ensure top leadership drives the transformation.
	Clarify the mission	Pull together a guiding team powerful enough to guide a big change.	Establish a coherent mission and integrated strategic goals to guide the transformation.
	Get the structure right	Create clear, simple, uplifting visions and sets of strategies.	Focus on a key set of principles and priorities at the outset of the transformation.
	Seize the moment (urgency / right time)	Communicate the vision through simple, heartfelt messages sent through multiple channels so that people begin to buy into the change.	Set implementation goals and a timeline to build momentum and show progress from day one.
	Communicate, communicate, communicate	Empower people by removing obstacles to the vision.	Dedicate an implementation team to manage the transformation process.
	Involve key players	Create short-term wins that provide momentum.	Use the performance management system to define responsibility and assure accountability for change.
	Engage employees	Maintain momentum so that wave after wave of change is possible.	Establish a communication strategy to create shared expectations and report related progress.
	Persevere	Make change stick by nurturing a new culture.	Involve employees to obtain their ideas and gain their ownership for the transformation.

Organizational Transformation Key Success Indicators

1. Ensure top leadership drives the transformation
2. Establish a clear vision and integrated strategic information goals
3. Design the organizational structure that will enable the vision
4. Create a sense of urgency, implementation timeline, and show progress from day one
5. Communicate frequently through multiple channels to multiple stakeholders
6. Dedicate a powerful implementation guidance team to manage the transformation process
7. Engage employees to see their improvement ideas, build momentum, and gain their ownership for the transformation
8. Sustain the effort by nurturing a new culture, rewarding risk, and measuring progress

The Organizational Change Readiness Framework reflects the amalgamation of areas for critical focus according to the change experts listed above. This chart illustrates the synthesis of common areas of importance found in all three change readiness best practice references. The collected works of three independent research projects garnered very similar conclusions as demonstrated by the color-coding alignment of the similarities.

The publications referenced represent a cross section of public sector (*Transforming Organizations*) and private sector *(Heart of Change*), with the *GAO Report* reflecting on both for best practice examples.

Authors of the frameworks above are the thought leaders in Organizational Transformation and Change Management. Research for all three published works includes in-depth academic study as well as work, consulting experience, and data collection with an extensive group of organizations.

Methodology References

- *GAO Report to Congressional Subcommittees, Results Oriented Cultures: Implementation Steps to Assist Mergers & Organizational Transformations,* GAO-03-669, July 2003
- Cohen, Dan and Kotter, John. *"The Heart of Change."* Boston, Harvard Business School Press, 2002.
- *Transforming Organizations*. Edited by Marc A. Abrahamson and Paul R. Lawrence, Lanham, MD. Rowman and Littlefield Publishers, 2001

Appendix I: References

CHIPS and Science Act of 2022, Pub. L. No. 117-167, 136 Stat. 1366 (2022), https://www.congress.gov/117/plaws/publ167/PLAW-117publ167.pdf.

Consolidated Appropriations Act, 2022, Pub. L. No. 117-103, 136 Stat. 49 (2022), https://www.congress.gov/117/plaws/publ103/PLAW-117publ103.pdf.

Consolidated Appropriations Act, 2023. Pub. L. No. 117-328, 136 Stat. 4459 (2022), https://www.congress.gov/bill/117th-congress/house-bill/2617/text.

National Science Foundation. Accelerating Research Translation (ART) Program Solicitation NSF 23-558. Alexandria, VA, 2023. https://www.nsf.gov/pubs/2023/nsf23558/nsf23558.htm.

National Science Foundation. Assessing and Predicting Technology Outcomes (APTO) Program Solicitation NSF 23-600. Alexandria, VA, 2023. https://www.nsf.gov/pubs/2023/nsf23600/nsf23600.htm.

National Science Foundation. Building the Prototype Open Knowledge Network (Proto-OKN) Program Solicitation NSF 23-571. Alexandria, VA, 2023. https://www.nsf.gov/pubs/2023/nsf23571/nsf23571.htm.

National Science Foundation. Dear Colleague Letter: NSF Regional Innovation Engines (NSF Engines) Program, NSF 22-082. Alexandria, VA, 2022. https://www.nsf.gov/pubs/2022/nsf22082/nsf22082.jsp.

National Science Foundation. Dear Colleague Letter: Visionary Interdisciplinary Teams Advancing Learning (VITAL) Prize Challenge, NSF 23-042. Alexandria, VA, 2023. https://www.nsf.gov/pubs/2023/nsf23042/nsf23042.jsp.

National Science Foundation. Enabling Partnerships to Increase Innovation Capacity (EPIIC) Program Solicitation NSF 23-528. Alexandria, VA, 2023. https://www.nsf.gov/pubs/2023/nsf23528/nsf23528.htm.

National Science Foundation. Experiential Learning for Emerging and Novel Technologies (ExLENT) Program Solicitation NSF 23-507. Alexandria, VA, 2023. https://www.nsf.gov/pubs/2023/nsf23507/nsf23507.htm.

National Science Foundation. FY2021 Budget Request to Congress. Alexandria, VA, 2020. https://nsf-gov-resources.nsf.gov/about/budget/fy2021/pdf/fy2021budget.pdf.

National Science Foundation. FY2022 Budget Request to Congress. Alexandria, VA, 2021. https://www.nsf.gov/about/budget/fy2022/pdf/fy2022budget.pdf.

National Science Foundation. FY2023 Budget Request to Congress. Alexandria, VA, 2022. https://nsf-gov-resources.nsf.gov/about/budget/fy2023/pdf/fy2023budget.pdf.

National Science Foundation. FY24 Budget Request to Congress. Alexandria, VA, 2023. https://nsf-gov-resources.nsf.gov/2023-

07/NSF%20FY24%20CJ_Entire%20Rollup_web_%28ERRATA%20v3%29.pdf?VersionId=dU2e1YVP9YcNvxC4eTrtDW0UQGZJEfye.

National Science Foundation. Innovation Corps – National Innovation Network Teams Program (I-Corps TM Teams) Program Solicitation NSF 21-552. Alexandria, VA, 2021. https://www.nsf.gov/pubs/2021/nsf21552/nsf21552.htm.

National Science Foundation. Learning Agenda FY 2022-FY 2026. Alexandria, VA, 2022. https://nsf-gov-resources.nsf.gov/2022-04/NSF_FY22-FY26%20Learning%20Agenda%20Final.pdf.

National Science Foundation. NSF Convergence Accelerator Phase I and II Program Solicitation NSF 20-565. Alexandria, VA, 2020. https://www.nsf.gov/pubs/2020/nsf20565/nsf20565.htm.

National Science Foundation. NSF Partnerships: Landscape Study. Alexandria, VA, 2020. https://www.nsf.gov/pubs/2021/nsf21201/nsf21201.pdf.

National Science Foundation. NSF Small Business Innovation Research (SBIR)/ Small Business Technology Transfer (STTR) Programs Phase I (SBIR/STTR Phase I) Program Solicitation NSF 22-551. Alexandria, VA, 2022. https://www.nsf.gov/pubs/2022/nsf22551/nsf22551.htm.

National Science Foundation. U.S. National Science Foundation 2022-2026 Strategic Plan. Alexandria, VA, 2022. https://www.nsf.gov/pubs/2022/nsf22068/nsf22068.pdf.

National Science Foundation. Partnerships for Innovation (PFI) Program Solicitation NSF 23-538. Alexandria, VA, 2023. https://www.nsf.gov/pubs/2023/nsf23538/nsf23538.htm.

National Science Foundation. Pathways to Enable Open-Source Ecosystems (POSE) Program Solicitation NSF 22-572. Alexandria, VA, 2022. https://www.nsf.gov/pubs/2022/nsf22572/nsf22572.htm.

SAM.GOV. "NSF Regional Innovation Engines Broad Agency Announcement." National Science Foundation. Updated October 18, 2022. https://sam.gov/api/prod/opps/v3/opportunities/resources/files/ac5c02c52705449f92241813c5f7f85e/download?&status=archived&token=.

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1600 K Street, NW
Suite 400
Washington, DC 20006

Phone: (202) 347-3190
Website: www.napawash.org