Leading the World in Discovery and Innovation, STEM Talent Development and the Delivery of Benefits from Research ~ NSF Strategic Plan for Fiscal Years 2022-2026

Never have science and technology been more important to the nation. Society is confronted by a growing set of challenges that call for the insights that science and engineering can provide. Advances in how we learn, work, collaborate and explore are creating opportunities to greatly increase the rate of discovery and broaden participation in S&E. An increasingly diverse global research community is enriching the breadth of questions that can be asked and answered. To both seize these opportunities and address these challenges, NSF will pursue a vision built on three pillars:

- Advancing the frontiers of research and innovation
- Ensuring accessibility and inclusivity
- Being a leader in the global S&E enterprise

These pillars rest on a foundation of people, ideas, partnerships and the translation of fundamental research into benefits for society. Our vision emphasizes the importance of interweaving innovation in everything we do. It will enable NSF to strengthen at speed and scale the delivery of its mission to the American people. For NSF to achieve this vision, requires not only advancing the frontiers of science, engineering and education, but also ensuring that U.S. research is an inclusive enterprise that harnesses the talent of all sectors of American society – a research enterprise that incorporates the rich demographic and geographic diversity of the nation.

Contents

National Science Foundation (NSF)

Description:

The U.S. National Science Foundation (NSF) is an independent federal agency that supports research at the frontiers of current knowledge, across all fields of science, engineering and education. It was established by the NSF Act of 1950 (Public Law 81-507). NSF adopted the purpose of that Act as its mission: to promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense. This has guided NSF's activities ever since.

NSF Stakeholders :
Stakeholder Engagement ~ Stakeholders took as their starting point the key elements of the NSF 2018-2022 Strategic Plan and provided comments and suggestions to inform the new plan. In addition to comments from individuals and organizations received through an online portal, agency officials held discussions with stakeholder groups, including the National Science Board, numerous advisory committees, academic organizations, professional societies and NSF staff.

National Science Board

Advisory Committees

Academic Organizations

NSF Staff

Vision

A nation that leads the world in science and engineering research and VISION innovation, to the benefit of all, without barriers to participation.

Mission

To promote the progress of science to advance the national health, prosperity and welfare; to secure the national defense; and for other purposes

Values

Scientific Leadership: NSF's strength is scientific leadership. ~ We support the expansion of the frontiers of knowledge and the integration of that knowledge into industry and education.

Diversity: We value the knowledge, skills, abilities, experiences and perspectives that colleagues from different backgrounds bring to our work and workplace. We recognize that these things strengthen NSF's ability to fulfill its mission.

Inclusion: We strive to maintain a staff that is representative of the broader national community. We support outstanding researchers and innovative thinkers from across our nation's diversity of regions, organizations and demographic groups.

Integrity: We hold each other and our awardees to the highest standards of ethical behavior. We strive to ensure the trustworthiness of the results of NSF-funded research. We ensure decisions are fairly made and communicated respectfully.

Excellence: We maintain the highest standards in merit review, financial management, award administration and business operations. We use rigorous review by experts to ensure that only the best ideas are funded. We apply new and creative ideas to improve our processes and our impact.

Public Service: We proudly value our role as public servants who enable the research community to identify new paths for expanding knowledge and addressing societal challenges.

Innovation: We apply new and creative ideas to improve our processes and our impact.

Collaboration: We work in a collaborative enterprise where teamwork is essential. We value the perspectives and values of our colleagues, recognize that combining our knowledge enables us to find more robust solutions and acknowledge the contributions that we each make to our shared success; we are committed to listening, communicating effectively and working collegially. We share both ideas and responsibilities with colleagues in pursuit of common goals.

1. Empowerment

Empower STEM talent to fully participate in science and engineering

S&E are key to the nation's economic progress, and people are the core of America's scientific progress. To accelerate the advancement of discovery and learning, prepare for a world in which work is increasingly reliant upon scientific and technological skills and ensure that all citizens share in the benefits that flow from research, we must promote inclusion in the research community and STEM workforce, access to STEM learning and training and widespread STEM literacy. Our global competitiveness depends critically on the readiness of the nation's STEM workforce, but millions of talented individuals are missing from that workforce. NSF seeks to empower these missing millions15 by making strategic investments in researchers and research training to harness the talents and creativity of America's diverse population. NSF also supports research into practical ways to promote a scientifically literate U.S. population that is well prepared for the economy and challenges of the 21st century. The Learning Agenda in Appendix A.1 of this plan contains a set of specific questions to help NSF assess progress on the strategic objectives listed under this goal. These reflect a guiding question: How can NSF grow STEM talent and opportunities for all Americans most equitably?

1.1. Accessibility & Inclusivity

Increase the involvement of communities underrepresented in STEM and enhance capacity throughout the nation.

Ensure accessibility and inclusivity ~ Our nation's STEM workforce must reflect the diversity of our society. This is essential for the emergence of a rich set of ideas and approaches that drive discovery and innovation. In addition, our research portfolio must tackle the challenges faced by all sectors of society; for example, environmental research to explore ways of addressing environmental change that benefit the full range of socioeconomic communities across America.

1.1.1. Demographic Diversity

Capitalize on the talents and ideas of all segments of the population

Demographic Diversity ~ A student's socioeconomic or demographic background should not be a limiting factor in their choosing to earn a STEM degree, or in support of that pursuit. Through programs such as ADVANCE and NSF INCLUDES (Inclusion Across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science) and their successors, NSF fosters institutional transformation within research and educational organizations so the nation can capitalize on the talents and ideas of all segments of the population. Through its research training activities, NSF invests in the broad diversity of STEM talent, aiming to advance racial equity and a STEM workforce that is more representative of our nation.

Stakeholder(s):
ADVANCE Program   **NSF INCLUDES Program**

1.1.2. Geographic Diversity

Expand the geography of innovation by advancing research capacity in states and territories that receive relatively small proportions of the federal research budget

Geographic Diversity ~ Talent is found throughout the United States. NSF's Established Program to Stimulate Competitive Research (EPSCoR) is an example of a program that seeks to expand the geography of innovation by advancing research capacity in states and territories that receive relatively small proportions of the federal research budget. NSF will expand its efforts to ensure all parts of the U.S. participate in the 21st century S&E enterprise.

Stakeholder(s):
Established Program to Stimulate
Competitive Research

1.1.3. Institutional Diversity

Increase the range of institutions we support

Institutional Diversity ~ To maximize the impact of its research training, NSF works to increase the range of institutions it supports. Through tailored, capacity-building programs, NSF enhances the ability of specialized institutions to draw diverse communities into research and the STEM workforce. Specialized programs can also help the nation meet emergent needs for a workforce trained in the new results of research in areas such as cybersecurity, quantum information science and AI.

1.1.4. Accessibility

Improve Accessibility

Improving Accessibility ~ As a preeminent funder of research, it is vital for NSF to ensure that everyone with potential has an opportunity to contribute to advancing the research frontier. NSF will continue to modernize its outreach to potential new investigators and institutions, combining both direct in-person outreach, support for research development assistance efforts of external partners, and online tools to make it easier to submit proposals and manage grants. By promoting the participation of undergraduates, graduate students and postdoctoral associates from all communities in research projects, as well as by providing graduate and postdoctoral fellowships and research experiences to an intentionally diverse array of undergraduates, K-12 students and teachers, NSF supports the development of a new generation of researchers, scholars and knowledge workers that better represents our pluralistic society. It prepares both future research leaders and a STEM workforce that is equipped with up-to-date knowledge and the experience needed to address society's current and future challenges. Indicators of progress towards this objective could include increases in the proportion of proposals that come from groups, regions and types of organizations that are underrepresented in NSF's proposal portfolio.

1.2. STEM Workforce

Grow a diverse STEM workforce to advance the progress of science and technology.

Unleash STEM talent for America ~ Tomorrow's advances in S&E will be accomplished by people educated today, in K-12 and college settings as well as in informal environments. One of NSF's most important approaches to advancing the progress of science and technology is to inspire and invest in the development of the next generation of our nation's STEM workforce, both within and beyond the academic environment. By leveraging its investments in research training and research on STEM learning, NSF supports a national effort to grow the next generation of discoverers and skilled technical workers and, in the process, entrain the missing millions and increase the diversity of the STEM workforce. This includes support for research that will develop and test new models for the lifetime integration of career and technical training, to keep pace with the ever-expanding frontiers of knowledge.

Stakeholder(s):
STEM Workforce

1.2.1. STEM Education

Support research in STEM education and on effective approaches to preparing a diverse, globally competent STEM workforce and a STEM-literate citizenry

Research on STEM Education ~ NSF supports research in STEM education and on effective approaches to preparing a diverse, globally competent STEM workforce and a STEM-literate citizenry. The research in learning in which NSF invests is aimed at both formal and informal pathways. Formal education through the nation's K-12 schools provides the foundation for citizens' understanding of STEM and its uses in addressing the needs of society. The formal education process continues through our nation's colleges and universities, where scholarship is the hallmark. Informal education — from the nation's science museums to children's educational television — is a powerful means to diffuse knowledge, provide learning and instill interest in STEM topics in everyone throughout their lives. NSF invests in research about education to develop more effective approaches to engage the public and help citizens develop a better understanding of science and the scientific process. NSF's investments in research on STEM education extend the reach of its S&E programs by paving the way to integrating their results into modern approaches to learning. Programs such as Improving Undergraduate STEM Education and Innovations in Graduate Education involve research that leads to improvements in undergraduate and graduate STEM programs, while Education and Human Resources Core Research advances learning, learning environments, workforce and broadening participation at all levels.

1.2.2. Formal Education & Training

Invest in postdoctoral, graduate and undergraduate research training

Formal Education and Research Training ~ Institutions of higher education in the U.S. play an important role in educating a diverse STEM workforce beyond preparing students for careers in research. NSF invests in postdoctoral, graduate and undergraduate research training through funding for research projects, research centers and research fellowships and by providing research experiences for undergraduates at home and abroad. NSF funds research on ways to improve graduate and undergraduate education to prepare students to participate in the nation's scientific and technological workforce. It provides opportunities for institutions of higher education to pilot new approaches to education that put the results of this research to good use. And NSF pursues innovations in undergraduate education aimed at better preparing the skilled technical workforce of the future. These efforts support the nation in developing a STEM workforce with broad capabilities for careers in business, industry and academia. To strengthen the links between precollege teaching and the frontiers of knowledge, NSF supports research experiences for educators.

Stakeholder(s):
Institutions of Higher Education

1.2.3. Informal Education

Invest in research on informal education to engage the public and help citizens understand science

Informal Education ~ Informal education is another powerful means to diffuse knowledge, provide learning and instill interest in STEM topics in everyone throughout their lives. Citizen-engaged science, for example, fosters informal education and involves citizens in a meaningful, gratifying way as it advances science at the same time. NSF invests in research on informal education that is intended to develop more effective approaches to engaging the public and to help citizens develop a better understanding of science and the scientific process. Indicators of progress towards this objective could include increases in the number and diversity of students, teachers and members of the public who participate in NSF formal and informal education activities.

2. Discovery

Create new knowledge about our universe, our world and ourselves.

This goal furthers the first part of NSF's mission, "to promote the progress of science," pursuing the generation of new knowledge so the nation remains a global leader in expanding discovery in science, engineering and learning. By generating new knowledge, NSF-funded researchers provide the nation with the capability to maintain scientific, technological and economic leadership in a competitive world. Fundamental research is a capital investment for the nation. Basic research leads to new knowledge. It provides scientific capital. It creates the fund from which the practical applications of knowledge must be drawn. New products and new processes do not appear full-grown. They are founded on new principles and new conceptions, which in turn are painstakingly developed by research in the purest realms of science.17 Those practical applications of knowledge sometimes begin to be realized very quickly; for example, some of NSF's investments in research related to the SARSCoV-2 pandemic produced actionable results within months. In other cases, the practical applications may not be fully felt until decades after the initial basic research. A connection between fluid dynamics and an improved industrial process may be easier to foresee than the practical benefits of fundamental physics research into what Einstein called "spooky action at a distance," but the initial research on quantum mechanics in the early 20th century paved the way for the development of new approaches to secure communications and more powerful computers that is underway in the 21st century's research on quantum information systems.

2.1. Ideas, People & Infrastructure

Accelerate discovery through strategic investments in ideas, people and infrastructure.

Advance the frontiers of research

2.1.1. Investments

Support a continuum of research from exploratory to solutions-focused

A Spectrum of Research Investments ~ NSF's core objective is to improve the collective understanding of the natural, human and built facets of the universe we inhabit. To achieve this, we pursue a strategy that strengthens the U.S. research enterprise by scaling up effective approaches to research and research training in ways that speed the pace of discovery. We support a continuum of research from exploratory to solutions-focused. We look to expand partnerships with philanthropic foundations and industry to quicken the pace of discovery and the dissemination of the knowledge gained. We invest in discovery and discoverers in all areas of science, technology and STEM education research. We seek the best research ideas, both those that advance current understanding and those that disrupt it. We support world-class scientific facilities for the nation's researchers at home and abroad. We support the development and acquisition of advanced research platforms, instrumentation and cyberinfrastructure, providing 21st century tools for 21st century research.

2.1.2. Impact

Formulate research questions whose answers will have a meaningful societal impact benefits

Research with Impact ~ The formulation of research questions whose answers will have a meaningful societal impact benefits from engaging stakeholders outside the research community. In some cases, the execution of such research can be strengthened by the active involvement of stakeholders in shaping and facilitating the research and evaluating intermediate results. Through workshops, specific solicitations and standing programs, NSF helps focus the attention of the research community on fundamental aspects of high-priority national challenges. We support researchers in identifying particularly urgent questions and opening up new avenues to

address these priorities. And we provide funding to pursue better understanding of specific challenges that confront society. These approaches promote impact-driven, use-inspired research.

2.1.3. Innovation & Entrepreneurship

Expand use-inspired research and fosters a national innovation ecosystem

Innovation and Entrepreneurship ~ Innovation and entrepreneurship are key capabilities for the nation. NSF's investments in S&E research and training foster innovation across a broad range of topics relevant to technological and economic competitiveness. Examples include advanced manufacturing, the design of innovative materials and building technologies, infrastructure resilience and sustainability, mitigating and adapting to the effects of global environmental change, innovations in AI, decision-making, cybersecurity and data analytics. Through its Convergence Accelerator, Partnerships for Innovation and I-Corps programs, NSF expands its use-inspired research portfolio and fosters a national innovation ecosystem by encouraging institutions, scientists, engineers and entrepreneurs to explore the innovation and commercial potential of their research. The rate at which the frontiers of science advance is notoriously difficult to quantify; however, an example of an indicator of progress could be trends in publications and citations, such as those highlighted in the biennial report Science and Engineering Indicators.

Stakeholder(s):

Convergence Accelerator	**Entrepreneurs**
Partnerships for Innovation Program	**Institutions**
I-Corps	**Scientists**
Innovators	**Engineers**

2.2. Research Capability

Enhance research capability

Enhance research capability ~ NSF will promote an academic culture that encourages risk taking, is broadly inclusive in both its demography and range of intellectual ideas, has access to cutting-edge infrastructure and is globally engaged with increased opportunities for exchanging ideas and collaborating on an international scale. It will increase opportunities for broadening the training of U.S. graduate students and early career researchers through international exchange activities and partnerships with industry.

2.2.1. Research Practice

Advance the state of the art in research practice.

Advance the state of the art in research practice ~ NSF seeks to advance the state of the art in research and strengthen the speed and scale at which the outputs from research benefit society. We will do this by encouraging innovation; strengthening partnerships between academic researchers, industry and other stake-holders; cultivating an inclusive and ethical research culture; embracing the growth of convergence as an approach to research; emphasizing the synergy between curiosity-driven and use-inspired research; supporting training in entrepreneurship and innovation; and supporting new modes of research practice. Research practice will also be advanced by promoting open data sharing; strengthening and broadening the community of research organizations; ensuring a safe, nurturing and inclusive research environment for all participants; leveraging partnerships with industry, civic society organizations and others to accelerate the pace of discoveries and their translation into benefits for society; and piloting new approaches to the formulation of research questions and the pursuit of their answers.

2.2.2. Collaboration & Interdisciplinarity

Supporting collaborative and interdisciplinary research

Collaboration and Interdisciplinarity ~ There is growing consensus that some of the most intractable problems in the scientific, technological and social arenas require perspectives and approaches from multiple disciplines. Indicators include the proliferation of multidisciplinary institutes and centers in academia and the private sector, new faculty hires with joint appointments and the merging of university departments. NSF has long recognized the potential synergies that result in such settings and the creativity that collaborative research and "team science" can bring to addressing some of society's most pressing research challenges. Convergent research, together with open data sharing among disparate disciplines, can lead to unprecedented breakthroughs and nucleate entirely new disciplines. NSF remains committed to maintaining a wide variety of mechanisms for supporting collaborative and interdisciplinary research at scales from small teams to multi-institutional centers.

2.2.3. Reproducibility

Ensure that research is reproducible

Reproducible research ~ Working with the research community, NSF will promote the use of best practices to ensure that research is reproducible, including emphasizing the open availability of results and the data that support them. Indicators of progress towards this objective could include growth in the number of records in NSF's Public Access Repository.

3. Impact

Benefit society by translating knowledge into solutions.

NSF has since its creation in 1950, impacted society not only in the U.S. but also around the world. From groundbreaking discoveries used for medicine and gene therapies to cybersecurity research that protects individuals, corporations and governments alike, NSF has been at the forefront of scientific discovery and technological advancements improving society for this generation and the next.

3.1. Societal Challenges

Advance research and accelerate innovation that addresses societal challenges.

Deliver benefits from research

3.1.1. Research & Innovation

Connect Research and Innovation

Connecting Research and Innovation ~ The first part of NSF's mission is to create new knowledge and expand the nation's intellectual capital. However, NSF's mission does not end there. To advance the national prosperity, we must continue to invest in research that: (1) connects new knowledge to innovations that drive the nation's competitiveness and fuel the nation's economic growth; and (2) addresses present and emerging societal needs. NSF will continue to pursue connections between new insights and global challenges (often involving essential interdisciplinary collaborations, prototypes and technologies). One approach to developing these connections is through partnerships to promote and catalyze the translation of research into application. NSF will expand its partnerships with other government agencies, academia and private and international entities. Such partnerships leverage NSF's resources and help ensure that fundamental research outcomes are translated into benefits to society.

3.1.2. Global Collaborations

Support U.S. researchers' involvement in global research collaborations

Engaged Research ~ Tools to advance research that provides the capability to meet pressing societal needs include: increasing support for the coproduction of discoveries; supporting mechanisms and training for researchers in techniques to promote the beneficial uptake of the results of their use-inspired research; and diversifying the research workforce to bring a broader range of perspectives to the generation of research questions. In the coming years and decades, the increasing impact of humanity on the natural world – and the increasing rate and reach of the communication of ideas in the digital world — will present the research community with urgent and increasingly global questions. Such questions include how to mitigate increasingly pervasive pollution, how to slow or adapt to the accelerating pace of environmental and ecosystem change, how to handle the emergence of new diseases, and how to address the dissemination of misinformation. To tackle these challenges, NSF will support U.S. researchers' involvement in global research collaborations. The research discoveries and technological advances supported by NSF have never been more important to both daily life and the long-term challenges that confront national and global society.

Stakeholder(s):
U.S. Researchers

3.1.3. Knowledge Dissemination

Encourage use of novel means of disseminating new knowledge

Open Research ~ To accelerate both research and innovation, it is critical to make results and knowledge widely available.20 NSF will continue to promote the rapid and wide-spread dissemination of the results of NSF-funded research with no or minimal restrictions from publication embargoes. It will encourage the use of novel means of disseminating new knowledge. And it will expand its efforts to ensure that the data cited to support published research are readily available to other researchers and well curated. Access to data is important not only so that others can build on published results but also so that key results can be tested to ensure they are reproducible. Indicators of progress towards this objective could include growth in the number of partnerships spanning academia, industry, nonprofits, and state and local government resulting from NSF grants. NSF anticipates these partnerships being greatly accelerated by the Directorate for Technology, Innovation and Partnerships' investments.

Stakeholder(s):
**Directorate for Technology, Innovation
and Partnerships**

3.2. Global S&E Community

Cultivate a global S&E community based on shared values and strategic cooperation.

Lead globally ~ The critical importance of research and innovation as drivers of future growth is recognized around the world. As noted by the U.S. Congress, many countries are increasing their investments in fundamental research. The focus on international collaboration in S&E is based on discovery, learning and research infrastructure to engage a diverse science community from different nations and cultural backgrounds. NSF develops international scientific collaborations on all seven continents and provides opportunities for researchers to enhance their work through international cooperation... As has been demonstrated many times, the impact of domestic talent is magnified when NSF also attracts foreign talent to the research enterprise. NSF works with its federal partners to reduce barriers to such participation when it accords with the key values that underlie U.S. research. At the same time, NSF continues to enhance research security through the work of its Research Security Strategy and Policy staff, building on the report Fundamental Research Security. Indicators of progress towards this objective could include growth in the number of NSF awards that include international activity.

Stakeholder(s):
Global S&E Community

3.2.1. International Collaboration

Leverage NSF and world resources through international collaboration

A Global Footprint ~ NSF's Office of International Science and Engineering (OISE) leverages NSF and world resources through international collaboration to advance the frontiers of science. It promotes an integrated, foundation-wide, international engagement strategy and manages internationally- focused programs that are innovative and catalytic. OISE promotes innovation among the U.S. research community through access to international knowledge, infrastructure and capabilities.

Stakeholder(s):
Office of International Science and Engineering

3.2.2. Research Integrity

Reinforce the integrity with which international research is conducted

Research Integrity ~ It is vital that the U.S. remain a leader in the global S&E enterprise. In addition to generating new ideas and nurturing new discoverers and innovators, NSF leads through the values that it brings to scientific work, including open inquiry, integrity and inclusion. U.S. researchers in international collaborative projects reinforce the integrity with which international research is conducted, promote open access to data and broaden the range of participants involved.

3.2.3. Infrastructure

Continue to participate in international research infrastructure development

Global, Secure Collaboration ~ NSF facilitates the participation of U.S. scientists and engineers in international research partnerships. Many of today's great scientific challenges, such as climate change, the degradation of environmental services, food security and the availability of fresh water and clean energy, are global in scale and require global solutions. Pioneering observations in physics and astronomy increasingly require complex infrastructure designed and implemented by teams of hundreds or thousands of experts from around the world. Because of this, NSF must continue to participate in international research infrastructure development.

3.2.4. Black Hole

Capture images of a black hole

A Global Effort: Imaging a Black Hole ~ The Event Horizon Telescope (EHT) – a planet-scale array of eight ground-based radio telescopes forged through international collaboration – was designed to capture images of a black hole. In 2019, researchers succeeded in obtaining the first direct visual evidence of a supermassive black hole and its "shadow."

Stakeholder(s):
Event Horizon Telescope

4. Excellence

Excel at NSF operations and management.

Excel ~ The first three strategic goals are associated with quickly evolving challenges. Meeting these and effectively fulfilling NSF's mission requires blending strong scientific leadership with robust organizational leadership. Both are characterized by vision and flexibility. NSF will reinforce its capacity to scale rapidly to advance an expanding portfolio that meets the growing need for breakthroughs in research and innovation. With the rapidly growing importance of exploratory and solutions-focused research for securing economic competitiveness and meeting pressing societal challenges, NSF must expand and strengthen the speed and scale at which research is conducted, research products are delivered and research and innovation communities grow.

4.1. Capacity & Capabilities

Pursue innovative strategies to strengthen and expand the agency's capacity and capabilities.

Strengthen at Speed and Scale ~ The four focus areas remain:

4.1.1. Processes

Strengthen and Streamline Processes

Strengthening and Streamlining Processes ~ NSF's goal of strengthening the speed and scale of its investments in fundamental research and their translation into societal benefits makes increases in the capacity and speed of internal processes essential. Such increases must be achieved while preserving timeliness, transparency, accuracy and accountability. To accommodate growth in NSF's portfolio and the rapid evolution in the nature of research and the research community, NSF continually reexamines its organizational structure and processes to make sure that they adapt and scale to the changing role of the agency. One example of this is the Renewing NSF activity, which began in the summer of 2017. NSF will pursue sustainable enterprise excellence through a continuing agency-wide change initiative that builds on the foundational work of Renewing NSF. This initiative aims to enhance performance of NSF's mission and maintain U.S. leadership in research and education across all areas of STEM. This effort is aligned with NSF's history of continuous organizational improvement. It will yield an even more agile organization better prepared for future challenges and opportunities. The four focus areas remain: • Making information technology work even better for all; • Adapting the workforce and the work • Streamlining, standardizing and simplifying processes and practices; and; • Expanding and deepening public and private partnerships.

Drawing on lessons learned in the SARS-CoV-2 pandemic, one anticipated change in NSF's processes will be the transition to a structure in which, on any given day, an increased number of staff members are working remotely, compared to before the pandemic, and many review panels, oversight visits and scientific meetings are conducted virtually. This transition will require new training in areas ranging from the management of remote workers to the successful facilitation of meetings conducted by videoconference. It will also require greater use of collaboration software. At the same time, this transition provides opportunities to expand the pool of talent from which NSF can draw, whether in recruiting reviewers or hiring staff. The growth of mechanisms to allow virtual participation by NSF staff in site visits and scientific and other types of professional meetings reduces the burden imposed by frequent travel and enables both scientific and business operations staff to maintain stronger connections with their networks of professional colleagues. These stronger connections to the research, grants management and business operations communities will enable NSF to maintain greater awareness of the evolving research frontier and engagement with the new researchers joining the S&E community.

4.1.2. Tech & KM

Capitalize on new technologies and emerging data analytics capabilities and expand our capabilities for analysis and knowledge management

New Technologies and Knowledge Management ~ NSF will continue to capitalize on new technologies and emerging data analytics capabilities and pursue vigorously the expansion of its capabilities for analysis and knowledge management. These are needed not only to assess internal operational performance and processes, but also to track and anticipate trends in research and to monitor and oversee progress in the construction of major facilities. NSF program officers and reviewers rely upon the agency's information systems and analytic capabilities to enable the outstanding merit review process that undergirds NSF's global reputation. Also essential is maintaining a safe and secure physical and cyber environment. NSF relies heavily on IT for all of its processes — including financial transactions, merit reviews and personnel records — but IT is also the gateway to communication and interaction with stakeholders in the research community. As trends towards a mobile workforce and remote work continue, IT will only become more important. Work on the Renewing NSF theme of making IT work even better for all will help position NSF to take advantage of advances in information technologies, including AI, automation and the growing availability of shared services.

4.1.3. Organizational Structure

Evolve our structure to better accommodate growth

An Evolving Structure ~ Periodically, when a new field or type of activity that NSF has nurtured has reached a critical mass, NSF has evolved its structure to better accommodate that growth. This plan coincides with the creation of a new Directorate for Technology, Innovation, and Partnerships (TIP) that will advance research and innovation leading to breakthrough technologies and solutions to national and societal challenges. This directorate will constitute a crosscutting platform that leverages, energizes, and rapidly brings to market and to society the innovations that result from all of NSF's investments. Further, TIP will open up new possibilities for research and education by catalyzing strategic partnerships linking academia, industry, government, philanthropy, investors and civil society to cultivate 21st-century local, regional and national innovation ecosystems. The agency will continue to be ready to adapt its structure and processes as its budget and responsibilities grow

4.1.4. Administrative Services

Continuously improve business processes, financial management and policies and associated infrastructure

Administrative Services ~ To accomplish its mission in research and education while maintaining its outstanding stewardship of taxpayer resources, NSF requires a wide range of operational and administrative services. These include human resource management, procurement, IT, financial management, program management, project management and administrative support. Built on a commitment to openness and transparency, NSF will follow a strategy of continuous improvement in business processes, financial management and policies and associated infrastructure. This may include the pursuit of partnerships and shared services as a means of promoting excellence and efficiency, as well as innovation in support of a mobile workforce and the use of remote work practices. NSF will leverage all available authorities to ensure that the contracts, agreements and partnerships it enters allow for innovation, reduce burdens on NSF and its partners, and provide meaningful oversight as the need for operational and administrative services evolve.

4.1.5. Administrative Burden

Reduce Administrative Burden

Reducing Administrative Burden ~ Surveys of researchers have identified time preparing proposals and reporting progress on projects as a significant administrative burden. The time researchers spend on developing proposals that are highly rated by reviewers but nevertheless must be declined for lack of funds is a loss of productivity for the research enterprise. NSF will explore a number of remedies to this burden, including increasing award size and duration as budgets permit and pursuing partnerships with non-federal entities interested in collaborating in the support of research and innovation. In addition, NSF will continue its efforts to streamline and simplify reporting.

4.1.6. Risk Management

Expand methodical risk assessment across the foundation

Risk Management ~ NSF embraces enterprise risk management. This is applied throughout the life cycle of awards and to the oversight of major facilities, physical and cyber security and other operational processes. NSF is unique in its dynamic organizational structure, which has enabled it to adapt quickly and effectively to transformations in the science, engineering and education landscape. This structure also enables NSF to form effective partnerships across government, academia and industry. This dynamism and the philosophy of striving for continuous improvement reflect an organization that is constantly learning and evolving. Maintaining resilience in such an environment requires NSF to continue to identify and manage associated risks and opportunities. One example of these risks is a workforce that is in constant transition, with a significant proportion of the scientific staff serving as rotators for one- to four-year terms, coupled with natural attrition and retirement. Information technology systems must be upgraded continually to support evolving business processes as well as necessary security and privacy protections. NSF will encourage an expansion of the use of methodical risk assessment across the foundation, including identifying, ranking, analyzing, tracking, controlling, accepting, transferring and mitigating risks; developing associated contingency management plans; and planning and implementing strategies that effectively manage and mitigate risk factors. Management challenges identified by the Inspector General will also be an input to this risk management framework. NSF will continue to promote a highly consultative culture, in which appropriate stakeholders are engaged early and throughout risk management processes.

4.1.7. Climate Impact

Examine ways to reduce the climate impacts of our operations

Climate Impact ~ Recognizing the importance of reducing direct and indirect emissions of greenhouse gases, NSF will examine ways in which it can reduce the impacts of its own operations by, for example, making greater use of virtual meeting technologies to reduce the need for travel by staff and reviewers.

4.1.8. Performance & Impact

Assess Performance and Impact

Assessing Performance and Impact ~ NSF employs data-driven decision-making. Through an internal evaluation and assessment of current capability and the use of tools such as strategic reviews and the NSF Learning Agenda (see Appendix A.1), NSF will expand its capabilities to assess the performance and impacts of its business processes and programs. Indicators of progress under this objective could include a measure of the

reliability of NSF's information technology resources to ensure that critical information and IT systems are available to support staff and our awardees in their pursuit of NSF's mission.

4.2. Workforce

Attract, empower and retain a talented and diverse NSF workforce.

Invest in People ~ One key prerequisite of being able to scale up the pace of discovery and innovation through strengthened NSF investments is a workforce that is engaged, highly capable and diverse. NSF cultivates adaptability and flexibility, furthering the agency's ability to proactively respond to an ever-changing landscape. NSF strives to help prepare a diverse, globally competent STEM national workforce and STEM-literate citizenry, and these goals are also reflected inward. NSF's development of a globally competitive workforce harnesses diverse perspectives that promote innovation and advance the Foundation's mission.

4.2.1. Human Capital Management

Position NSF to readily adapt in a changing scientific and technological environment

To be an effective organization, NSF cultivates capabilities that enable it to be nimble and innovative by using flexible human capital processes that position NSF to readily adapt in a changing scientific and technological environment. From recruitment to development and retention of exceptional administrative and business professionals, scientists and engineers, NSF's investments in human capital, and its commitment to its staff, are rooted in the knowledge that people make scientific exploration and discovery possible.

4.2.1.1. Hybrid Workforce

Move toward a hybrid workforce

One component of the Renewing NSF effort involves NSF moving toward a hybrid workforce, which will enable the agency to have a geographically diverse presence, increasing the agency's ability to effectively recruit the best and brightest talent throughout the nation.

4.2.1.2. Positions

Analyze and assess NSF's current positions and visualize future positions

Another component involves analyzing and assessing NSF's current positions and visualizing future positions. This will strengthen the Foundation's ability to rationalize the many types of position descriptions that NSF uses, standardize career ladders to facilitate greater mobility of staff across the organization and increase the pathways for staff members to advance. It will also ensure that the agency identifies the current and future competencies and skills that are required to harness new technologies and techniques, assess gaps and design a path to ensure employees are poised to meet the future needs of the agency. For example, as skills such as data science and machine learning become more critical, NSF anticipates that the capacity of the agency workforce in these areas will be enhanced through specific hiring and training activities.

4.2.1.3. Programs

Implement the Program Management Improvement and Accountability Act

Another component of Renewing NSF is NSF's continued implementation of the "Program Management Improvement and Accountability Act" (PMIAA). Leveraging the competency tools and training resources developed for the Major Facility/Acquisition portfolio, NSF will target other significant programs within the broader awards portfolio where program and project management skills are necessary to enable successful program outcomes and enhance agency performance. Training and development plans for NSF staff associated with these programs will incorporate internal resources from the NSF Academy (described below) as well as those being developed by other agencies that are implementing PMIAA.

Stakeholder(s):
NSF Academy

4.2.1.4. Recruitment, Hiring & Promotion

Create a balanced workforce of permanent and rotating staff members

NSF uses various hiring authorities to create a balanced workforce of permanent and rotating staff members. The recruitment and promotion processes are strengthened by internal training on the nature of unconscious bias and techniques to mitigate it. Diversity in backgrounds and perspectives is a powerful resource; NSF strives to maintain a workforce that is inclusive at all levels and in all units within the foundation.

4.2.2. Training & Development

Nurture the development of in-house managerial talent

Through an emphasis on leadership training, coaching and detail assignments, NSF nurtures the development of in-house managerial talent from within its ranks to complement the opportunities provided through external hiring.

4.2.2.1. Rotators

Recruit rotators from academia and elsewhere

By recruiting rotators from academia and elsewhere and actively engaging permanent staff in professional society conferences and research community workshops, and through its Independent Research/Development program, NSF maintains its essential, strong connection to the forefront of science, engineering and education research.

Stakeholder(s):
Academia

4.2.2.2. Conferences & Workshops

Engage staff in professional society conferences and research community workshops

4.2.2.3. Work Environment

Provide an environment that bolsters employee enthusiasm and psychological commitment to the mission and vison of NSF

NSF leadership fosters an inclusive and engaging workplace for employees by providing employees with an environment that bolsters employee enthusiasm and psychological commitment to the mission and vison of NSF. NSF has an active employee engagement program that is reinforced by a host of work/life programs, which are continuously reviewed to ensure the programs address the challenges faced by employees.

4.2.2.4. Education & Training

Provide a wide array of education and training opportunities for staff members

To further support an inclusive and engaged workplace, NSF supports a learning culture for all staff by providing a wide array of education and training opportunities for staff members that strengthen the capacity of the Foundation and increase its value to the nation. This support is exemplified in the value placed on employee training and development.

Stakeholder(s):

NSF Academy :
In addition to opportunities for external training, NSF maintains a strong internal resource, the NSF Academy, that continuously develops and disseminates cutting-edge information aimed at enhancing the know-how of the agency's staff.

4.2.2.5. Teamwork

Further skills in communication, collaborative work and other tools to enable highly effective teams

In keeping with its aspiration to be a high-performing organization, NSF provides a vehicle for its employees to learn how to work more efficiently and more creatively, furthering their skills in communication, collaborative work and other tools to enable highly effective teams. This equips employees to meet current and future agency needs and to be utilized to their fullest potential. NSF provides its managers with the requisite toolkit for managing effectively, offering opportunities to learn and enhance skills that are tailored to new and experienced managers, respectively.

4.2.3. Employee Engagement

Engage employees

The high performance of NSF's workforce is crucial to the fulfillment of the agency's mission. NSF rewards exemplary performance through a variety of employee recognition programs.

4.2.3.1. Performance & Recognition

Reward exemplary performance through employee recognition programs

4.2.3.2. Commuications

Promote internal and external communications

NSF promotes strong internal and external communications, ensuring staff and community stakeholders are both engaged in and informed about organizational change. NSF employees learn and grow in important ways that contribute to the organization as a whole and enable NSF to function as a model federal agency.

4.2.3.3. Workplace

Make NSF one of the best places to work in the federal government

NSF leadership works hard to make NSF one of the best places to work in the federal government. To that end, the information gained from the Federal Employee Viewpoint Survey (FEVS) and other employee feedback mechanisms is highly valued by leadership. Expectations for maintaining an inclusive and engaging workplace are held high by leadership, as demonstrated by the time and resources devoted to maintaining NSF's high relative rankings as compared to other federal agencies. Indicators of progress under this objective could include a measure tracking NSF's implementation of its Human Capital Operating Plan, which identifies the actions the agency will take to achieve its human capital goals.