TIP 2023 ANNUAL IMPACT REPORT

CHIPS and Science Act of 2022; Section 10399

U.S. National Science Foundation
Directorate for Technology, Innovation and Partnerships

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Annual Report of the U.S. National Science Foundation Directorate for Technology, Innovation and Partnerships

Background

This report responds to Public Law No. 117-167, "Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act of 2022," which specified the following requirement:

Section 10399. *Reports and roadmaps. (a) Annual report. — The Director [of the U.S. National Science Foundation] shall provide to the relevant authorizing and appropriations committees of Congress an annual report describing projects supported by the [Technology, Innovation and Partnerships] Directorate during the previous year.*

Overview

Established by the "National Science Foundation Act of 1950" (Public Law No. 81-507), the U.S. National Science Foundation is an independent federal agency whose mission is "to promote the progress of science; to advance the national health, prosperity and welfare; to secure the national defense; and for other purposes." NSF is unique in carrying out its mission by supporting fundamental and translational research and education across all fields of science, technology, engineering and mathematics.

In 2022, under the leadership of Director Sethuraman Panchanathan, NSF announced the establishment of the Directorate for Technology, Innovation and Partnerships (TIP), the agency's first new directorate (or major unit) in more than 30 years. Just a few months later, the "CHIPS and Science Act of 2022" specifically authorized the establishment of the directorate and charged it to:

"support translational research, accelerate the development and use of federally funded research, strengthen U.S. competitiveness through development of key technologies, and expand student and researcher participation and the U.S. workforce in key technologies and in areas of societal, national, and geostrategic importance."[1]

TIP is meeting this charge through investments in three key areas:

1. Fostering diverse innovation ecosystems regionally and nationally;

2. Accelerating technology translation and development; and

3. Growing the workforce by enabling the participation of talent from all backgrounds, sectors, and geographic locations, and at all levels, in the STEM-driven economy of the 21st century.

In other words, TIP advances use-inspired and translational research in all fields of science and engineering, giving rise to new industries while engaging all Americans in new, high-wage, good-quality jobs. This first-ever annual report details the accomplishments of the NSF TIP Directorate through August 2023, which constituted the first anniversary of the "CHIPS and Science Act of 2022."

1 https://www.congress.gov/bill/117th-congress/house-bill/4346/text

Fostering diverse innovation ecosystems

TIP aims to catalyze a paradigm expansion for the U.S. research and innovation ecosystem by bringing together researchers, practitioners and users who collaboratively shape use-driven research directions, pursue iterative co-design and co-creation, and test new technologies and solutions in practical settings. TIP aims to encourage the market and society in the conduct of research, accelerating the "demand pull" for STEM research and workforce development. In this way, TIP is developing key technologies and addressing pressing national, regional, societal and geostrategic challenges. The directorate's impact is embodied in its dynamic programs, including investments that foster diverse innovation ecosystems regionally and nationally.

NSF Regional Innovation Engines

Notably, pursuant to section 10388 of the "CHIPS and Science Act of 2022," the NSF Regional Innovation Engines (NSF Engines) program[2] catalyzes and fosters regional-scale innovation ecosystems throughout the U.S., with the explicit goals of:

- advancing key technologies;
- addressing pressing national, regional, societal and geostrategic challenges;
- cultivating partnerships spanning the full range of sectors, including industry, academia, government, nonprofits, civil society, and communities of practice;
- promoting and stimulating economic growth and job creation; and
- spurring regional innovation and talent.

Each NSF Engine can receive up to $160 million over 10 years to support the development of diverse, regional, multi-sector coalitions to conduct use-driven research and development as well as to train the local workforce for new, high-wage, good-quality jobs. Through this unprecedented level of investment as well as a framework for building and sustaining innovation ecosystems, the NSF Engines will enable new regions, including those that have been underrepresented in the technology boom of the last several decades, to become national and global leaders in specific topic areas aligned with their local competitive advantages. Teams have the option to receive two years of funding via NSF Engine Development Awards to plan for future NSF Engines.

2 https://new.nsf.gov/funding/initiatives/regional-innovation-engines

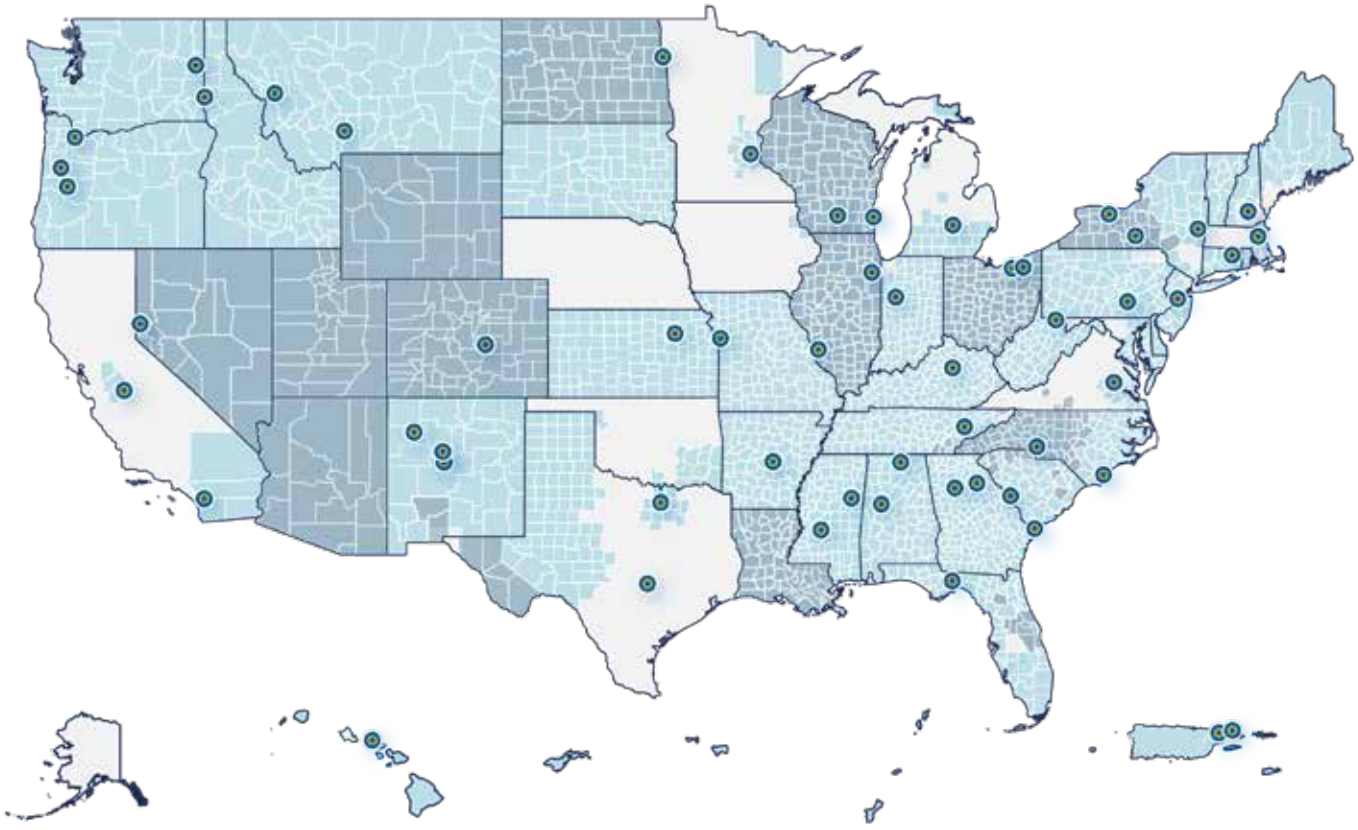

Figure 1. *NSF Regional Innovation Engines Development Awards. View the interactive map.*

Awards

In May 2023, NSF awarded NSF Engine Development Awards to 44 unique teams spanning universities, nonprofits, businesses and other organizations across 46 U.S. states and territories. Each awardee team received up to $1 million for two years. These awards will help organizations create connections and develop their local innovation ecosystems over a two-year period to prepare strong proposals for becoming future NSF Engines.

In June 2023, as part of a separate but parallel competition to the NSF Engine Development Awards described above, NSF announced the semifinalists for the first NSF Engines awards. In early August, NSF further narrowed that list, announcing 16 finalists for the NSF Engines competition. Each of the finalists will receive an on-site review to assess further their goals, plans, milestones, risks and committed resources, as well as the team's ability to adapt to changing circumstances. NSF anticipates announcing the NSF Engines awards in early 2024, with each awardee initially receiving about $15 million for the first two years.

Enabling Partnerships to Increase Innovation Capacity

Establishing more inclusive innovation ecosystems will require broad networks of partners working together in support of use-inspired research, the translation of such research to practice or commercial application, and the development of a skilled workforce. The Enabling Partnerships to Increase Innovation Capacity (EPIIC) program, a companion to the NSF Engines program, will broaden participation in innovation ecosystems by supporting capacity-building efforts at minority- serving institutions, predominantly undergraduate institutions and two-year institutions.[3] EPIIC will provide these participants the training and support necessary to become equitable partners with teams competing under the current and subsequent NSF Engines program funding opportunities.

A $20 million investment in Fiscal Year 2023, EPIIC will provide up to $400,000 over three years per award to develop the capacity and institutional knowledge needed to build new partnerships and secure future external funding, enabling awardees to tap into their regional innovation ecosystems.

Awards

The EPIIC program was announced in December 2022. Through a third party, NSF provided training and other support to 50 organizations as they developed their proposals; this was a relatively new approach, one that TIP considered critically important to appropriately engage with diverse institutions that did not have significant prior experience writing proposals to and receiving funding from NSF. NSF anticipates announcing EPIIC awards in winter 2023.

NSF Convergence Accelerator

National-scale economic and societal challenges cannot be solved by a single discipline. Instead, these challenges require convergence, or the merging of innovative ideas, approaches and technologies from a range of disciplinary areas to build upon basic research and discovery and accelerate solutions toward impact. The NSF Convergence Accelerator (CA) program invests in teams to solve economic and societal challenges through convergence research and innovation.[4] To enhance its impact, the CA program places teams together in cohorts, synergizing their work through facilitated collaboration, ideation and team science. The CA program provides a unique opportunity for researchers to collaboratively advance key technologies and develop critical and novel solutions to pressing national, regional, societal and geostrategic challenges at scale.

Awards

In FY 2022, the CA program initiated four new tracks across a wide range of topic areas, namely **Track G:** Securely Operating Through 5G Infrastructure, **Track H:** Enhancing Opportunities for Persons with Disabilities, **Track I:** Sustainable Materials for Global Challenges, and **Track J**: Food & Nutrition Security. To date, these tracks represent over 60 teams focused on developing new technologies and solutions for enduring economic and societal impacts.

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3 https://new.nsf.gov/funding/opportunities/enabling-partnerships-increase-innovation-capacity

4 https://new.nsf.gov/funding/initiatives/convergence-accelerator

New Convergence Accelerator Funding Opportunities

In FY 2023, the CA program issued a new funding opportunity for three new research track topics resulting from ideation workshops over the prior year, namely **Track K:** Equitable Water Solutions, **Track L:** Real-World Chemical Sensing Applications, and **Track M:** Bio-Inspired Design Innovations. These new tracks continue the CA program's goal of employing a convergence approach, which merges innovative ideas, approaches, and technologies from a wide and diverse range of disciplines and sectors to solve global-scale economic and societal challenges.

CA partnerships

The CA program offers a unique opportunity to collaborate and partner with organizations. For example, to date, TIP has partnered with one other federal agency as well as two international funding organizations to increase the program's impact:

- **Track G** is a partnership with the Department of Defense Office of the Under Secretary of Defense for Research and Engineering.
- **Track I** is a partnership with Australia's Commonwealth Scientific and Industrial Research Organization.
- **Track L** is a partnership with two Swedish government agencies advancing research and innovation — the Swedish Research Council (or Vetenskapsrådet) and Vinnova, Sweden's innovation agency.

Technology translation and development

TIP accelerates the translation and development of breakthrough technologies. New programs are focusing on use-inspired and translational research in specific subareas within the key technology focus areas codified in the "CHIPS and Science Act of 2022." Additionally, TIP programs provide pathways for researchers, startups, small businesses and aspiring entrepreneurs to move their ideas from the lab to the market and society.

Lab-to-Market Platform

TIP accelerates the translation of research results to practical use through its Lab-to-Market Platform.

Partnerships for Innovation

The Partnerships for Innovation (PFI) program offers researchers from all disciplines of science and engineering funded by NSF the opportunity to perform translational research and technology development, catalyze partnerships and accelerate the transition of discoveries from the laboratory to the marketplace for societal benefit.[5] The PFI program supports use-inspired and translational research toward proofs-of-concept of future products, processes and/or services, prototype development, demonstration of commercial potential and the enhancement of partnerships among U.S. institutions of higher education, nonprofits and for-profit companies. PFI supports researchers from all NSF-funded STEM disciplines. Aligned with the national priorities outlined in the "American Innovation and Competitiveness Act of 2017,"[6] the program helps researchers translate basic research into technologies and spurs university spinoff companies.

In FY 2023, NSF nearly doubled the PFI award sizes for the program's two tracks. The new funding opportunity offers a maximum budget of $550,000 per proposal for its Technology Translation (PFI- TT) track and up to $1 million per proposal for its Research Partnership (PFI-RP) track.

Awards

The PFI program has funded 40 projects since the CHIPS and Science Act of 2022 became law.

5 https://new.nsf.gov/funding/initiatives/pfi

6 https://www.congress.gov/bill/114th-congress/senate-bill/3084/text/enr

NSF Innovation Corps

The NSF Innovation Corps (I-Corps™) program is an entrepreneurial training program that facilitates the transformation of invention to impact.[7] This immersive, seven-week experiential training program prepares scientists and engineers to extend their foci beyond the university laboratory — accelerating the economic and societal benefits of NSF-funded and other basic research projects ready to advance toward commercialization.

Awards

I-Corps Hubs: In September 2022, NSF funded five additional I-Corps Hubs. These Hubs work collaboratively to build and sustain diverse and inclusive innovation networks across the country. Through its national and regional training programs, the NSF I-Corps Hubs train researchers to bring promising ideas from the lab to the market.

I-Corps Teams: More than 2,500 teams have participated in the I-Corps program since its inception in 2012. More than half of these teams, nearly 1,400, have launched startups that have cumulatively raised $3.16 billion in subsequent funding ($1.016 billion in public funding and $2.150 billion in private investment) — 10.5 times the federal investment in the NSF I-Corps program over the last decade (about $300 million). For more information, see the Biennial I-Corps Report[8] published in June 2023.

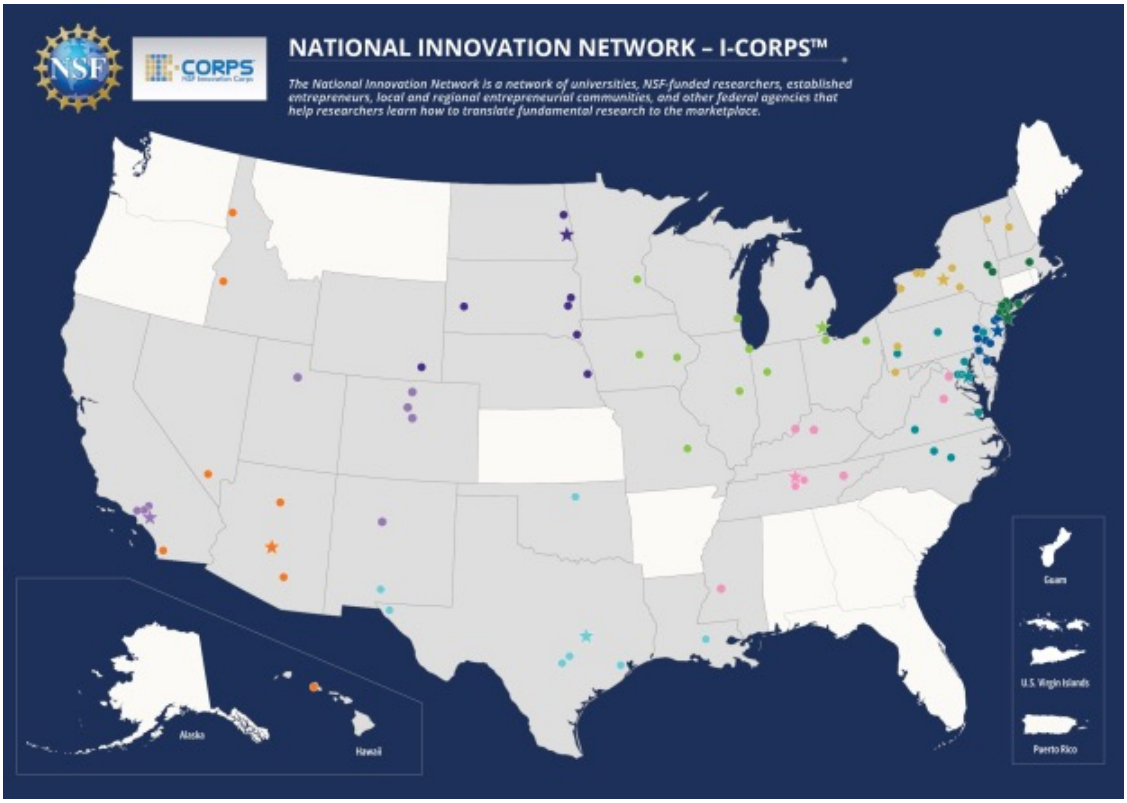

Figure 2. *NSF Innovation Corps (I-Corps) Hubs form the operational backbone of the National Innovation Network. View or Download the I-Corps™ Hubs Interactive Map.*

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7 https://new.nsf.gov/funding/initiatives/i-corps

8 https://nsf-gov-resources.nsf.gov/2023-06/TIP_I-CorpsReport_2023_Final_6.21.2023.508.pdf?VersionId=7hktpt_12oxeM2sHpOrTR6uG3mm6_DMk

America's Seed Fund, powered by NSF: Small Business Innovation Research and Small Business Technology Transfer

America's Seed Fund, powered by NSF, awards over $200 million annually to startups and small businesses, transforming scientific discovery into products and services with commercial and societal impacts.[9] Companies working across nearly all areas of STEM can receive up to $2 million to support research and development, helping de-risk technology for commercial success. Funded businesses must have the potential to positively benefit society and to lead to significant outcomes in the commercial market. Most of the startups funded by NSF have fewer than 10 employees, have been recently formed, and have not previously received funding from the government.

The NSF Small Business Innovation Research and Small Business Technology Transfer (SBIR and STTR) programs fund nearly all technology areas and market sectors (with the exception of clinical trials and schedule I controlled substances). NSF-funded startups and small businesses saw around 300 exits and more than $20 billion in private investments between FY 2016 and FY 2022, according to Pitchbook. For more information on the status of the NSF SBIR/STTR program, please refer to the Small Business Association report.[10]

Awards

Each year, roughly 400 companies receive NSF SBIR/STTR awards.[11]

9 https://seedfund.nsf.gov
10 https://www.sbir.gov/annual-reports-files
11 See a list of awards by year: https://seedfund.nsf.gov/awardees/history/?yr=2022&p1&p2&kw&pp&gv&st

New opportunities and pathways

Pathways to enable Open-Source Ecosystems

Launched in February 2022, the Pathways to enable Open-Source Ecosystems (POSE) program aims to harness the power of open-source development for the creation of new technology solutions to problems of national, regional, societal and geostrategic importance.[12] Many NSF-funded projects result in publicly accessible, modifiable and distributable open-source products, including software, hardware, models, specifications, programming languages or data platforms, that catalyze further innovation.

The overarching vision of POSE is that the proactive and intentional formation of managing organizations will ensure a broader and more diverse adoption of open-source products, increased coordination of external intellectual content developer contributions, and a more focused route to technologies with broad economic and societal impacts. The POSE program supports the formation of new open-source ecosystems (OSE), led by managing organizations, based on existing open-source products or classes of products, whereby each organization is responsible for the creation and management of processes and infrastructure needed for the efficient and secure development and maintenance of an OSE.

Awards

In September 2022, NSF announced the first POSE awards to more than 20 Phase I projects.[13] Researchers will create ecosystems for materials science research, renewable energy adoption, natural hazards, health data sciences and informatics, supply chain monitoring and many other important applications.

NSF anticipates making its first Phase II POSE awards by October 2023.

12 https://new.nsf.gov/funding/opportunities/pathways-enable-open-source-ecosystems-pose

13 https://new.nsf.gov/tip/updates/nsf-invests-nearly-8-million-inaugural-cohort-open

Growing translational capacity

As part of its mission to advance use-inspired and translational research, the NSF TIP Directorate aims to identify gaps in the progression from the lab to the market and society, developing new investment strategies and frameworks for addressing these opportunities. In its first year, TIP has pursued new pilots and programs that seek to better understand the technology translation landscape and test hypotheses about the role of federal investment in growing capacity and accelerating impact.

NobleReach Emerge Biotechnology Pilot

The NobleReach Emerge Biotechnology Pilot, a $5 million activity with NobleReach Emerge (formerly known as IQT Emerge), seeks to identify and accelerate the translation of NSF-funded research into biotechnologies and bio-inspired designs with commercial and societal impacts.[14] NobleReach Emerge will collaborate with NSF-funded research teams to identify, assess and advise on potential research pathways that are more likely to lead to product development. Working with a team of experienced commercialization advisors at NobleReach Emerge, this tailored needs assessment will help NSF-funded research teams address product development, go-to-market strategies, pitch deck creation and techno-economic analyses. This investment aims to serve as a model for creating a sustained national technology translation program for key technologies with broad national, regional, societal and geostrategic applications.

Awards

NSF staff will identify funded biotechnology research with the potential for commercial applications. NSF and NobleReach Emerge will narrow down to a subset of projects based on market research, grant analysis and investigator-readiness evaluations. Once potential projects are selected and engaged, the NobleReach Emerge team will work with the research teams to tailor their research efforts for market penetration.

Accelerating Research Translation

Aligned with section 10391 of the "CHIPS and Science Act of 2022," the Accelerating Research Translation (ART) program, announced in February 2023, constitutes a new investment designed to increase the scale and pace of translational research at U.S. institutions of higher education.[15] The primary goals of this program are to build capacity and infrastructure for translational research at diverse institutions of higher education and to enhance their roles in their regional innovation ecosystems. In addition, this program seeks to effectively train graduate students and postdoctoral researchers in translational research, benefiting them across a range of career options.

Awards

NSF anticipates making the first ART awards in the fall of 2023.

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14 https://new.nsf.gov/tip/updates/nsf-noblereach-emerge-partner-new-effort-speed

15 https://new.nsf.gov/funding/opportunities/accelerating-research-translation-art

Driving Technology Development

TIP accelerates breakthroughs in the key technology focus areas identified in section 10387 of the "CHIPS and Science Act of 2022" — such as advanced manufacturing, advanced materials, advanced wireless, artificial intelligence, biotechnology, quantum information science, and semiconductors and microelectronics — to grow long-term U.S. competitiveness and security. In addition to providing significant co-funding to existing programs in these areas led by other NSF directorates, TIP also aims to develop a portfolio of new investments specifically focused on maturing breakthrough technologies for eventual widespread technology deployment and use.

To identify and enable these investments, TIP has established a framework comprising four elements: forecasting, road mapping, investing and assessing.

Technology forecasting

The National Network for Critical Technology Assessment Pilot

In September 2022, TIP funded the National Network for Critical Technology Assessment (NNCTA) pilot to lay the foundation for the ability to assess U.S. global competitiveness in key technologies and identify where and how limited federal resources could be best applied to advance the nation's standing and the wellbeing of the American public.[16] Using data, advanced analytics and expert insights, the NNCTA pilot effort is identifying methods that could be employed to derive policy insights and develop an understanding of where additional analytical tools and data resources are needed to drive comprehensive analysis and decision-making.

Bringing together a multidisciplinary group of experts, the NNCTA pilot will pair a top-down approach to scan global capabilities in knowledge, production and human capital with a bottom-up approach to develop and demonstrate methods to identify opportunities for STEM investments to advance national competitiveness. The bottom-up approach will be accomplished through deep dives in four key technology areas: AI, biotechnology, energy storage and semiconductors. The outcomes of both approaches will be synthesized into a final report.

Final Report

The NNCTA pilot's final report will be published in September 2023 and will inform the Assessing and Prediction Technology Outcomes program described below.

16 https://www.nsf.gov/awardsearch/showAward?AWD_ID=2241237

Assessing and Predicting Technology Outcomes

In June 2023, TIP released the Assessing and Predicting Technology Outcomes (APTO) funding opportunity to develop the science that enables rigorous assessment of how investments in STEM research and development will contribute to specific outcomes for the nation.[17] The APTO program will support a cohort of projects that will work together to complement each other's research and development efforts on technology outcome models to accurately describe three types of technology outcomes: technology capabilities, technology production and technology use. These models will aim to predict future as well as past states of technology outcomes. Of particular interest are prediction models that are generalizable across multiple key technology areas. The outcome of this work will help assess and evaluate the effectiveness of U.S. research and development investments and generate information that decision-makers could use to strategize and optimize investments for advancing long-term U.S. competitiveness into the future. The APTO program serves the TIP Directorate's need for technology assessment to understand where the U.S. stands, as a whole and in individual regions, vis-à-vis competitiveness in the key technology focus areas.

Awards

TIP anticipates making awards in fall 2023.

Technology roadmapping

In May 2023, TIP released a request for information (RFI) seeking feedback from individuals and organizations across all sectors — industry, academia, nonprofits, government, venture capital, civil society and others — on prioritizing and focusing TIP investments to advance U.S. technological competitiveness and address pressing national, regional, societal and geostrategic challenges as well as workforce gaps through use-inspired and translational research, public and private partnerships, and crosscutting investments.[18] TIP requested comments by July 27, 2023, to inform the development of a roadmap to guide investment decisions in use-inspired and translational research over a three-year time frame, working towards the goal of advancing U.S. competitiveness in the key technology focus areas identified in section 10387 of the "CHIPS and Science Act of 2022," as well as addressing the national, regional, societal and geostrategic challenges also identified therein. Investments would be in use-inspired research, translation of research results to impact, and education, training, and development of talent. In July 2023, TIP partnered with an external research team for technical and analytical assistance in the analysis of RFI responses and other relevant information in the development of a Technology Roadmap for TIP.

17 https://new.nsf.gov/funding/opportunities/assessing-predicting-technology-outcomes-apto

18 https://new.nsf.gov/tip/updates/nsf-seeks-input-develop-investment-roadmap

Technology investing

Building the Prototype Open Knowledge Network

The Building the Prototype Open Knowledge Network (Proto-OKN) program, announced in March 2023 in collaboration with five other U.S. government agencies, supports the creation of a prototype OKN — an interconnected network of knowledge graphs supporting a very broad range of application domains.[19] The National Aeronautics and Space Administration, National Institutes of Health, National Institute of Justice, National Oceanic and Atmospheric Administration and the U.S. Geological Survey will support the program by working closely with NSF and the Proto-OKN awardees to ensure the Proto-OKN supports each agency's data strategy while addressing use cases associated with the agencies' data.

The Proto-OKN initiative follows investments through the NSF Convergence Accelerator Track A: Open Knowledge Networks, as well as a yearlong OKN Innovation Sprint conducted by NSF and the White House Office of Science and Technology Policy in 2022. The OKN Innovation Sprint engaged nearly 150 subject matter experts, end users and constituents from government, industry, academia, nonprofits and other communities and culminated in an Open Knowledge Network Roadmap that outlined a path to an OKN and informed this funding opportunity.

Awards

NSF will make its first Proto-OKN awards in the fall 2023.

Privacy-Enhancing Technologies Prize Challenges

In collaboration with the United Kingdom (U.K.), NSF, the National Institute of Standards and Technology and the Office of Science and Technology Policy launched the Privacy-Enhancing Technologies (PETs) Prize Challenges in July 2022.[20] With a prize pool of $1.6 million, innovators were challenged to develop privacy-preserving federated learning solutions that enable AI models to be trained on sensitive data without organizations having to reveal, share or combine their privacy-sensitive data. The first track — aimed at transforming financial crime prevention — spurred technological innovation to tackle the challenge of international money laundering by developing privacy-preserving models that can identify anomalous transactions. The second track of the challenges — aimed at bolstering pandemic response capabilities — aimed to strengthen readiness for ongoing and future public health emergencies by developing privacy-preserving solutions that can forecast an individual's risk of infection. Privacy-preserving technologies hold the potential to advance innovation and collaboration in new fields and help harness the power of data to tackle some of the most pressing societal challenges.

19 https://new.nsf.gov/funding/opportunities/building-prototype-open-knowledge-network-proto

20 https://new.nsf.gov/news/us-uk-launch-innovation-prize-challenges-privacy; https://petsprizechallenges.com

Awards

In November 2022, the U.K. and U.S. announced 12 prize-winning technical papers for the first phase of the PETs Prize Challenges. The winners of phases two and three were announced at the second Summit for Democracy held in March 2023. In these final phases, participating teams built the solutions envisioned by their technical papers and engaged with regulators and government agencies to inform the development of solutions. Leading solutions from phase two were then tested by multiple independent red teams to verify the privacy protections provided, and the results of this vetting determined the final rankings of the prize winners.

Visionary Interdisciplinary Teams Advancing Learning Prize Challenge

NSF partnered with the Bill & Melinda Gates Foundation, Schmidt Futures and the Walton Family Foundation to catalyze the translation of research discoveries into breakthrough learning technologies through a $6 million Visionary Interdisciplinary Teams Advancing Learning (VITAL) Prize Challenge.[21] The three-phase, one-year challenge encouraged interdisciplinary teams from the science and engineering research and startup or small-business communities to advance innovative concepts into prototypes for potentially game-changing learning technologies.

The VITAL Prize Challenge incentivized interdisciplinary teams to create innovative and translational K-12 learning technologies that synthesize recent discoveries in STEM with educational and training processes. Such use-inspired innovations possess the potential to equitably improve learning outcomes for all students and broaden learner engagement, especially when focused on the assets, needs and issues of traditionally marginalized groups. At scale, these technologies have the potential to impact the U.S. educational system and improve workforce development.

Awards

In April 2023, TIP announced that 100 interdisciplinary teams had advanced to the "Discovery Round" of the VITAL Prize Challenge. In July, NSF announced that 54 teams progressed from the Discovery Round to the Semi-Final Round.[22] Each semi-finalist team will receive an additional $20,000 in research and development funding to support the costs associated with early solution development. The teams chosen for the Semi-Final Round span the challenge's three technology tracks, including 17 teams developing learning technology concepts to advance mathematical literacy to promote a future STEM workforce, 15 teams advancing measures and tools that can dramatically increase the speed and utility of student learning information for educators, students and families, and 22 teams advancing other innovations to support diverse communities of K-12 student learners and teachers.

Final round winners will be announced in early 2024.

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21 https://new.nsf.gov/tip/vital-prize-challenge

22 https://new.nsf.gov/news/nsf-announces-54-teams-picked-vital-prize

Future of Semiconductors (FuSe)

The Future of Semiconductors (FuSe) program, a partnership between NSF, Intel Corporation, Ericsson Inc., IBM Corporation and Samsung, is cultivating a broad coalition of researchers and educators from across science and engineering communities in the pursuit of a holistic, co-design approach to fundamental research and workforce development in next-generation semiconductor design and manufacturing, with the overall objective of enabling rapid progress in new semiconductor technologies.[23] The future of semiconductor design and manufacturing will require the design and deployment of diverse new technologies in materials, chemical and materials processes, devices and architectures through the development of application-driven systems. Partnerships between industry and academic institutions are essential to inform research needs, spur innovation and technology transfer, and train a diverse future workforce. FuSe represents a multi-directorate program supported by TIP in collaboration with the NSF Computer and Information Science and Engineering, Mathematical and Physical Sciences, Engineering, and STEM Education directorates.

Awards

The three research topic areas identified for support in FY 2023 under the FuSe solicitation are collaborative research in domain-specific computing, advanced function and high-performance by heterogeneous integration, and new materials for energy-efficient, enhanced-performance and sustainable semiconductor-based systems. Awards are anticipated by fall 2023.

Technology assessments

TIP is formulating a high-level value creation framework and associated metrics to assess the directorate's progress in meeting the goals articulated in the "CHIPS and Science Act of 2022." This approach will quantify the three pillars underlying TIP's mission delivery, i.e., fostering diverse innovation ecosystems, accelerating technology translation and development, and nurturing the workforce. As TIP investments in technology development and translation expand, the value creation framework and associated metrics, together with logic models for each investment, will provide feedback that will inform future investments.

23 https://new.nsf.gov/funding/opportunities/national-science-foundation-future-semiconductors

Workforce development

TIP ignites partnerships among academia, industry, government, nonprofits, civil society and communities of practice to meet people where they are, providing pathways for learners and workers of all backgrounds and perspectives with access to the experiential and educational offerings that position them to participate in the 21st-century STEM-driven economy.

Experiential learning for emerging and novel technologies

In October 2022, TIP launched the Experiential Learning for Emerging and Novel Technologies (ExLENT) program to expand practical learning opportunities for individuals interested in entering or gaining more experience in emerging and novel technology areas such as advanced manufacturing, AI, biotechnology, quantum information science, and semiconductors and microelectronics.24 With awards of up to $1 million over three years, the ExLENT program will promote partnerships between organizations in key technology fields and those with expertise in workforce development. ExLENT offers three pathways for people with varying STEM experience levels, including:

- **Pivots**: Provides current professionals in any field an experiential learning opportunity that builds the skills and competencies necessary to pivot into careers in emerging technology fields;
- **Beginnings**: Provides participants with limited STEM training an experiential learning opportunity to gain deeper knowledge and experience to pursue a career in an emerging technology field; and
- **Explorations**: Provides participants with no prior STEM experience an experiential learning opportunity that builds interest, motivation, and knowledge in an emerging technology field and inspires them to further explore pathways to potential careers in these areas.

Awards

NSF anticipates making the first ExLENT awards in fall 2023.

NSF Entrepreneurial Fellowships

Pursuant to section 10392 of the "CHIPS and Science Act of 2022," NSF initiated the Entrepreneurial Fellowships investment in FY 2022 via a $20 million award to Activate Global Inc. (Activate).[25] The Activate Fellows supported by NSF are scientists and engineers from a variety of backgrounds and regions across the U.S. who will translate research breakthroughs to new products and services with broad societal benefits. Over two years, Activate Fellows supported by NSF will receive training and at least $350,000 in direct support, plus access to

24 https://new.nsf.gov/funding/opportunities/experiential-learning-emerging-novel-technologies
25 https://new.nsf.gov/tip/updates/nsf-launches-entrepreneurial-fellowship-engineers

specialized research facilities and equipment. The Fellows will advance their prototypes, refine their business models, build their teams and secure follow-on funding. The NSF Entrepreneurial Fellowship will also open opportunities for entrepreneurs in less-developed innovation ecosystems, expanding geographic diversity and increasing the participation of women and others who have been traditionally underrepresented in science, technology, engineering and mathematics.

Awards

In September 2022, NSF announced a $20 million award to Activate. Activate has since launched the first cohort of the Activate Anywhere Community, powered by NSF, comprising an initial 16 fellows, and also launched an Activate Houston community, which will begin supporting Fellows beginning in June 2024.

Additional workforce development initiatives

In 2022, NSF partnered with two corporate leaders in the semiconductor industry to educate and train the nation's semiconductor design and manufacturing workforce spanning all levels of innovation and production, including technicians, practitioners, researchers, entrepreneurs, and educators. TIP partnered separately with Intel Corporation and Micron Technology to improve and make available STEM education at two-year colleges and four-year universities, including at minority-serving institutions. These partnerships seek to leverage NSF and industry resources to jointly invest in the development of rigorous and engaging instructional material, teacher professional development, and experiential opportunities for students to improve their preparedness for the tens of thousands of job openings and corresponding workforce shortages anticipated in the semiconductor industry in the years ahead.

Future topics for workforce development in key technology career pathways

In May 2023, TIP and the STEM Education directorate jointly issued a request for information to seek input on novel approaches that lead to the recruitment of diverse and creative individuals into emerging technologies fields.[26] The input will help NSF inform future funding opportunities to accelerate efforts to increase both the rate and overall composition of domestic students enrolled in traditional academic pathways into STEM disciplines that will lead to careers in key technologies. Of equal priority is interest in developing funding opportunities that focus on flexible, non-traditional pathways into key technology careers, through support of continuous lifelong learning as a critical strategy to access high-wage, good-quality jobs in these areas. Ultimately, NSF seeks input on ways to make educational pathways into key technology careers accessible to any American interested in participating in the U.S. research and innovation enterprise. Responses were requested by the end of June 2023, and TIP will use these to inform, refine and catalyze future investments in workforce development.

26 https://www.nsf.gov/pubs/2023/nsf23100/nsf23100.jsp

Industry engagement and partnerships

As part of its mandate to grow public and private partnerships to advance the nation's research and innovation enterprise, TIP hosted an "NSF Industry Partnership Summit" in April 2023.[27] More than 50 industry leaders from a range of sectors came together to explore effective models for public and private partnerships that would speed the development of key technologies, address national, regional, societal and geostrategic challenges, and advance workforce development. Through co-investing with NSF on research, education and infrastructure, companies can complement their traditional research and development investments, leverage and expand available funding to achieve their longer-term goals, broaden participation in their research and development activities and fill their workforce needs. The Industry Partnership Summit allowed NSF to hear from a strategic set of corporate science and technology leaders on effective strategies as well as nontraditional approaches to enhance public and private partnership models. The result was a prioritized list of topics relevant to joint investment and associated models for engagement. As a follow-on to the summit, TIP has formed industry working groups to refine this list and develop ways forward, including specific joint investments.

27 https://new.nsf.gov/tip/updates/nsf-hosts-first-ever-industry-partnership-summit

The year ahead

The “CHIPS and Science Act of 2022” authorized the establishment of the NSF TIP Directorate and charged it with the critical mission of advancing U.S. competitiveness through investments that accelerate key technologies and address pressing national, regional, societal and geostrategic challenges. TIP is meeting this mission through new and existing programs and pilots that build diverse innovation ecosystems across all parts of the nation, accelerate use-inspired research to impact, and create new pathways for people of all backgrounds and perspectives to participate in the STEM workforce.

In the coming year, TIP will award the first-ever NSF Engines; announce critical investments in capacity building through programs like EPIIC and ART; continue to accelerate use-inspired technology development through the CA and other focused investments; expand technology transfer through programs like I-Corps, SBIR/STTR, and POSE; and nurture the workforce through the inaugural cohort of ExLENT awards. Of note, TIP strives to pursue pilot activities with testable hypotheses that can be evaluated and assessed over time.

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