IDA SCIENCE AND TECHNOLOGY POLICY INSTITUTE

REPORT TO THE PRESIDENT FISCAL YEAR 2020

The Institute for Defense Analyses is a nonprofit corporation that operates three Federally Funded Research and Development Centers. Its mission is to answer the most challenging U.S. security and science policy questions with objective analysis, leveraging extraordinary scientific, technical, and analytic expertise.

LETTER FROM THE DIRECTOR OF STPI

Dear Mr. President:

On behalf of the IDA Science and Technology Policy Institute (STPI), it is my pleasure to present our congressionally mandated report of activities for fiscal year 2020. As a federally funded research and development center, we take pride in providing the Executive Office with in-depth, objective, fact-based analysis on a wide variety of science and technology issues.

STPI was established by Congress in 1991 to inform policy decisions of the Office of Science and Technology Policy (OSTP) in the Executive Office of the President. In 1998, Congress expanded STPI's mission to include reporting on significant trends and developments in science and technology in the United States and abroad; analyzing those trends with attention to the Federal science and technology portfolio; and performing studies that will ensure the long-term strength of American science and technology. Since 2003, we have been operated by the nonprofit Institute for Defense Analyses with sponsorship through the National Science Foundation.

Throughout a year marked by response to the global pandemic, STPI has been able to continue providing the highest caliber of analysis on some of the Nation's most pressing issues. We produced several analyses in support of the Federal pandemic response, including some rapid-response efforts in support of the OSTP Director's role on the White House COVID-19 Task Force. STPI analysts provided support for the President's Council of Advisors on Science and Technology, which was reestablished during this fiscal year. Other topics we worked on this year include Earth system predictability, Federal research and development policy, space technology and policy, resilience and infrastructure, and science, technology, engineering and mathematics (STEM) education and workforce.

Providing scientific and technical analysis to the Executive Office of the President is our primary mission, but we also help numerous other Federal agencies develop science and technology policies and assess their effectiveness, including the National Science Foundation, the National Aeronautics and Space Administration, the National Institutes of Health, and the United States Agency for International Development.

We are all deeply committed, both individually and as an institution, to keeping America at the forefront of scientific discovery and ensuring that American scientists and engineers continue to lead the world in innovation and technical progress. On behalf of all of my colleagues, I thank you for the opportunity to serve our government and to help advance our Nation's research and development endeavor.

Kristen M. Kulinowski, Ph.D.

ABOUT THE SCIENCE AND TECHNOLOGY POLICY INSTITUTE

The Science and Technology Policy Institute (STPI) was established by Congress in the National Defense Authorization Act for Fiscal Year 1991 (P.L. 101-510) 1991 as a federally funded research and development center (FFRDC) under the name Critical Technologies Institute. In 1998, Congress renamed the Institute as part of the National Science Foundation Authorization Act of 1998 (P.L. 105-207), which also assigned STPI the following duties:

- Assembly of timely and authoritative information regarding significant developments and trends in science and technology research and development in the United States and abroad.
- Analysis and interpretation of the information with particular attention to the scope and content of the Federal science and technology research and development portfolio as it affects interagency and national issues.
- Initiation of studies and analyses of alternatives available for ensuring the long-term strength of the United States in the development and application of science and technology.
- Provision, upon the request of the Director of the White House Office of Science and Technology Policy (OSTP), of technical support and assistance
  - to committees and panels of the President's Council of Advisers on Science and Technology, and
  - to interagency committees and panels of the Federal Government concerned with science and technology.

Consistent with congressional direction, STPI provides analyses of significant science and technology policies and developments in the United States and abroad for OSTP, its primary sponsor, and for other Federal Government organizations with science and technology responsibilities. To ensure the continued relevance of its work, STPI meets frequently with the Director and staff of OSTP. Such close coordination—coupled with a flexible tasking process—ensures that STPI focuses on OSTP's top priorities and emergent problems.

To address STPI's broad science and technology charter, STPI researchers possess educational training and professional experience across the spectrum of disciplines and sectors. The majority of degrees among STPI's research staff are in mathematics, physical and life sciences, and engineering, with law, social science, communication, and history rounding out the staff's educational background.

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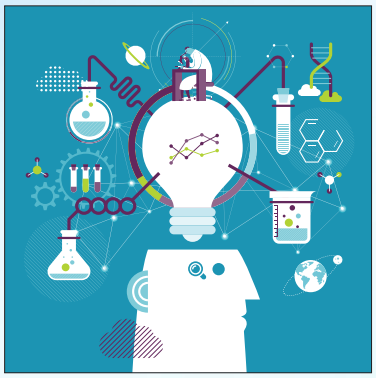
THE NATION'S RESEARCH AND DEVELOPMENT (R&D) ENDEAVOR



Bioeconomy

The U.S. bioeconomy represents the infrastructure, innovation, products, technology, and data derived from biologically-related processes and science that deliver economic, health, and public benefits. Example sectors of the bioeconomy include healthcare, pharmaceuticals, biotechnology, and agriculture. In the first phase of this project, OSTP asked STPI to describe the existing elements and potential future direction of the broader bioeconomy and also to determine urgent and strategic needs the Federal Government should consider for promoting the socially responsible use of health data and protecting the privacy and security of such data. STPI conducted a series of policy, legal, and scientific analyses to describe elements of the bioeconomy, outlined potential economic and national security vulnerabilities, and identified urgent and strategic areas that the Federal Government should consider to promote and protect the U.S. bioeconomy. The results of these analyses were used to inform the development of a formal interagency Bioeconomy Initiative.

To coordinate Federal efforts under the initiative, OSTP and National Security Council (NSC) staff asked for STPI's assistance with interagency coordination and developing policy documents. In response, STPI provided background materials for meetings; facilitated interagency working group discussions designed to solicit bioeconomy-related vulnerabilities and challenges from Federal subject matter experts; assisted OSTP with coordination of a Bioeconomy Summit with non-Federal stakeholders; and supported interagency technical writing groups in drafting an initial policy framework.

Biodefense metrics

The National Biodefense Strategy (NBS) outlines a plan and set of objectives to counter the threats that can occur from naturally occurring events, accidental events, and deliberate biological terrorism events. The NBS published in September 2018 prioritizes and coordinates Federal biodefense initiatives from 2018–2023. OSTP asked STPI for assistance in developing new metrics and a Science and Technology Roadmap for measuring progress and effectiveness of efforts to implement the NBS. STPI conducted policy analyses to map alignment of the NBS to the NBS Implementation Plan, identified areas of alignment between the NBS and the Implementation Plan, and created a methodology for developing metrics, milestones, and end-states that would guide mandatory annual NBS evaluation activities. STPI briefed OSTP sponsors, NSC and Office of Management and Budget (OMB) officials, and the interagency committee charged with coordinating implementation of the NBS. The results of STPI's efforts were used to inform the creation of new processes and methods for metrics development that will allow policy makers and appropriators to make informed decisions about progress in achieving the NBS goals and objectives.

Return on R&D investment

The National Institute of Standards and Technology (NIST) launched the Return on Investment (ROI) Initiative in 2018 to engage a wide stakeholder community on ways to improve the commercialization and other impacts of the Nation's $150 billion annual investment in R&D, especially in Federal intramural technology transfer. In support of the ROI Initiative, STPI reviewed background literature and reports on evaluation of intramural and extramural technology transfer and developed a concept model to support Federal agency development of measures and metrics to evaluate technology transfer activities. STPI developed the first conceptual model to date focused on Federal-wide technology transfer activities that broadly comprises technologies and knowledge transferred across parties. The results were documented in two reports that identified gaps in previously reported findings and will be used to inform NIST's plans and activities related to the ROI initiative.

Technology transfer

Improvement in the transfer of federally funded technologies from lab-to-market is a cross-agency priority (CAP) in the President's Management Agenda. OSTP and NIST are co-leading activities to streamline technology transfer under the National Science and Technology Council (NSTC) Lab-to-Market Subcommittee. OSTP asked STPI to support the Subcommittee by collecting data related to existing and recently initiated Federal activities, analyzing the results, and mapping them to CAP objectives and the Administration's R&D priorities. In addition to preparing background research and memos supporting deliberations, activities, and policy decisions, OSTP asked STPI for support in implementing some of the activities in the Subcommittee's action plan that was published in July 2019 on performance.gov. STPI also prepared and delivered a white paper on technology transfer metrics and their limitations that has informed the Federal lab-to-market community on best practices and been integrated into updated Federal guidance documents published by NIST.

Open science analysis

The Subcommittee on Open Science (SOS) of the NSTC's Committee on Science aims to advance open science and foster implementation of agency public access plans intended to improve access to data and publications resulting from federally funded R&D. As part of its work, SOS has developed a set of desirable characteristics of data repositories for data resulting from federally funded research. OSTP requested STPI support the SOS in two efforts related to its mandate. The first was to analyze responses to a request for comments (RFC) on the SOS's draft set of desirable characteristics of data repositories. The second was to analyze responses to a separate request for information (RFI) to get public comment on how changes to publication practices might affect the openness and transparency of scientific results. The results of the RFC analysis are being used by the SOS to finalize the principles for research repositories; the results of the RFI analysis are being used by OSTP and the SOS to continue work on Federal public access policies.

Open science disclosure risk management

In 2013, OSTP released a Memorandum for the Heads of Executive Departments and Agencies entitled, "Increasing Access to the Results of Federally Funded Scientific Research," that established the policy that Federal agencies should, to the extent practicable and consistent with law, ensure that publications and data derived from government funding of scientific research be freely accessible to the public. At the same time, openness has the potential to create risk should sensitive data be inadvertently disclosed or should the harvesting and joining of disparate low-risk datasets pose a danger to personal privacy, economic competitiveness, or national security. Six years into the implementation of the open science policy, OSTP and the NSTC Subcommittee on Open Science seek to collect and share best practices for identifying and mitigating disclosure risk without creating undue burdens on researchers and government program managers. As part of this effort, OSTP and the NSTC Subcommittee on Open Science asked STPI to provide logistical and analytical support for a workshop held in July 2019 convening leaders in the open science and risk assessment communities to predict and manage risks to U.S. national, homeland, and economic security as well as personal privacy, confidential business information, and dual-use research. In addition to helping manage the event, in December 2019 STPI delivered to OSTP the workshop report, entitled *Open Science Disclosure Risk Management: A Workshop Report and Corresponding Recommendations for the Federal Research Community*.

Open access and research security

In 2019, the NSTC established a joint committee of the Committee on Science and the Committee on Science and Technology Enterprise to address issues related to research environment safety, integrity, and productivity. One work stream of the joint committee is to consider how to the balance the benefits of preserving open access to American universities against the costs of protecting American research assets. The joint committee initially identified three focus areas: Federal agency conflict of interest/conflict of commitment policy, vetting of investigators and students participating in federally funded research activities, and Federal agencies' activities to communicate with their stakeholder communities on the matters of protecting research assets generally and vetting of conflict of interest/conflict of commitment issues. OSTP asked STPI to support the Joint Committee on the Research Environment (JCORE) Research Protections Subcommittee and assist in developing potential interventions and in identifying opportunities for interagency coordination. As part of its support, STPI analyzed the responses derived from the RFI on the American Research Environment related specifically to the JCORE Research Security Subcommittee.

Committee on Foreign Investment in the United States

The Committee on Foreign Investment in the United States (CFIUS) reviews investments in U.S. companies that may pose national security concerns. STPI works with OSTP to inform their implementation of CFIUS legislation, ongoing review of filings, and workflow.

The President's Council of Advisors on Science and Technology

The President's Council of Advisors on Science and Technology (PCAST) is an advisory group of leading scientists and engineers drawn from a variety of non-governmental sectors—industry, academics, non-profits—who advise the President and Executive Office of the President. PCAST provides policy recommendations and guidance in areas where understanding of science, technology, and innovation is key to strengthening the American economy and creating policy that works for the American people. STPI was commissioned by OSTP to provide technical support to PCAST in the form of information gathering and assessment, technical writing and editing, and project management for PCAST meetings and initiatives as needed. STPI provided support in the preparation of *2020 PCAST Recommendations for Strengthening American Leadership in Industries of the Future*, a report released by PCAST at their public meeting on June 30, 2020. STPI continues to provide support in PCAST's follow-up efforts focused on the creation of a new type of R&D partnership in the form of Industries of the Future Institutes.

Safe and inclusive research environments

The Director of OSTP chartered the NSTC's JCORE to bring together the NSTC Committee on Science and the Committee on Science and Technology Enterprise to coordinate interagency efforts to improve the safety, integrity, productivity, and security of the U.S. research environment. STPI activities informed the content and organization of the White House Summit of the Joint Committee on the Research Environment in November 2019, which highlighted an integrative approach to policy recommendations and best practices that address these issues.

In addition, OSTP asked STPI to assemble a full inventory of all Federal agency policies and practices that aim to address harassment in the research environment, perform an analysis on this information to identify gaps and promising practices, and describe potential actions for the Subcommittee to consider. STPI's findings are informing the ongoing activities of JCORE.

Administrative requirements for research

The American Innovation and Competitiveness Act of 2017 mandates the reduction of administrative burdens on federally funded researchers while protecting the public interest through the transparency of and accountability for federally funded activities. The Subcommittee on Coordinating Administrative Requirements for Research (CARR)

Subcommittee under NSTC's JCORE is responsible for facilitating the establishment of a centralized assurances repository and a centralized researcher profile database; simplifying and streamlining grants application requirements; maintaining accountability for Federal funding; and developing a process for simplified mandatory progress reporting. In its capacity of providing analytic support for the work of the CARR Subcommittee, STPI delivered a memo to OSTP entitled "Toward a Federal Research Impact Infrastructure Using Persistent Digital Identifiers" that informed an NSTC report that promotes agency use and guidance for implementation of persistent digital identifiers. In addition, STPI delivered a memo on "U.S. Federal Requirements for Individual Financial Conflict of Interest in Research" to OSTP In addition, as part of its support for CARR, STPI tracked agency application requirements and use of non-traditional grant submission and review processes (e.g., use of just-in-time information submission, pre-proposals, and modular budgets) that can serve as the basis for streamlining grant application procedures and reducing administrative burden for grant applicants.

Rigor and integrity in research

The NSTC Subcommittee on Rigor and Integrity in Research is intended to promote the foundational principles of integrity, honesty, transparency, openness, and mutual respect in the U.S. research enterprise as well as the robust reproducibility of research. The Subcommittee works to coordinate and promote current Federal efforts to enhance the quality, reproducibility, and replicability of federally funded research and to engage with the academic community to define and diffuse best practices for promoting research rigor and integrity. OSTP asked STPI to support the Subcommittee in three activities: (1) identifying cross-agency research rigor and integrity principles, (2) identifying incentives for funding agencies and other stakeholders to encourage reporting of null and negative research findings, and (3) engaging the scientific community in the collaborative development of principles and priorities that agencies could use to enhance research quality, reproducibility, and replicability. STPI supported a Roundtable on Rigor and Integrity in Research jointly sponsored by OSTP and the National Academies of Science, Engineering, and Medicine (NASEM). STPI also analyzed responses relevant to research rigor and integrity from an RFI issued by JCORE.

Earth system predictability

Knowing the extent to which components of the Earth system are practically predictable, from individual thunderstorms to long-term global change, is vitally important for the health, safety, and economic well-being of all Americans. Predictability is founded on physical understanding of the Earth system, but its importance lies not only in the assessment of the value of prediction results but also in guiding Federal investments, informing effective policy, and improving predictive skills. STPI supported the Fast Track Action Committee (FTAC) for the Earth System Predictability (ESP) Initiative in 2020 by providing a synthesis of outcomes from a Federal data survey, conducting a topical landscape analysis looking

at the literature and private sector activities in ESP, delivering initial elements of an RFI analysis, supporting a NASEM-OSTP co-sponsored roundtable to better understand the perspective of stakeholders, and providing logistics and strategic support for FTAC meetings and activities.

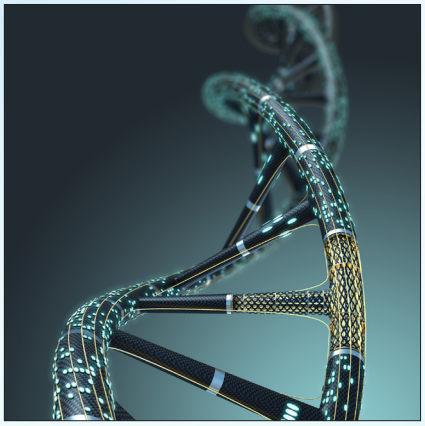
Ocean science

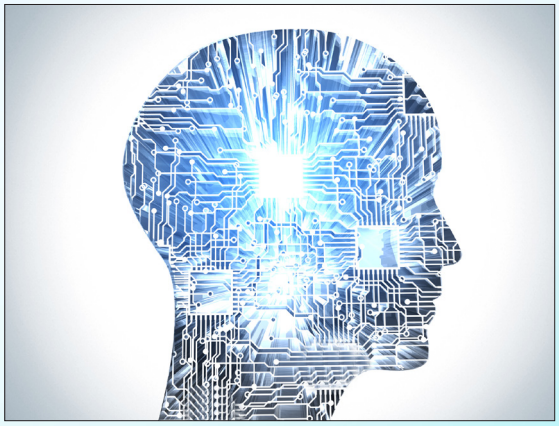
The White House Summit on Partnerships in Ocean Science and Technology followed the 2018 Executive Order, *Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States*, and the NSTC report, *Science and Technology for America's Oceans: A Decadal Vision,* both of which identify priority ocean research and technology needs. The Summit, co-organized with OSTP and the Council on Environmental Quality (CEQ), engaged a cross-section of the U.S. ocean community to develop a common direction to advance marine science, promote new technologies, and explore the ocean at a level of detail and geographic scale never before possible. STPI assisted OSTP and CEQ in drafting a summary of the Summit, documented town hall discussions on ocean science and technology partnerships at science society meetings, and helped draft and analyze an RFI.

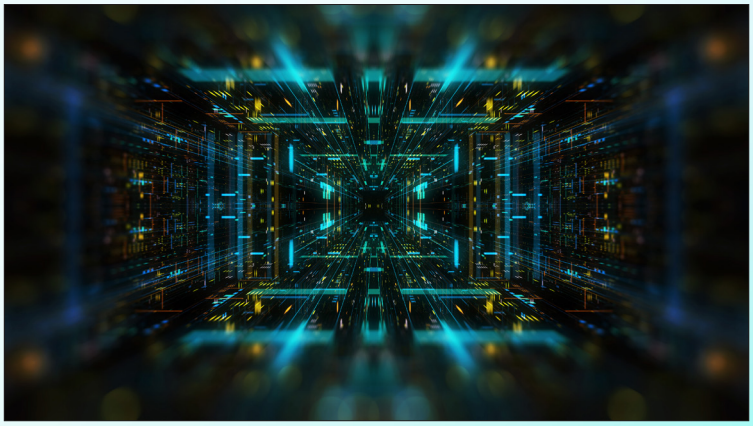
Earth observation

In 2019, the U.S. Group on Earth Observations (USGEO) developed and released the National Plan for Civil Earth Observation, which is intended to help coordinate federally supported Earth observations and investments, identify opportunities to advance Earth observations, and achieve national Earth observation policy objectives. The National Plan prioritizes identifying Earth observation systems that are at risk of being lost or terminated in the near-term (next 2–3 years). To support USGEO, OSTP asked STPI to mine the 2016 Earth Observation Assessment database—which includes information on 1,323 observing system inputs collected from 2014 to 2016, combined with up-to-date data provided by USGEO agencies—to identify assumed uses, unrecognized or indirect uses, and dependencies of Earth observation platforms and data products across the U.S. Earth Observation endeavor. In response to OSTP's request, STPI prepared a summary of highly connected observation data sources across the dataset and the specific societal benefit areas they serve with a focus on identifying key and intermediate products that are highly dependent on other products and the effects of removing keystone products on the broader U.S. Earth Observation ecosystem.

FEDERAL TECHNOLOGY POLICY







Quantum information science

Quantum information science (QIS) applies fundamental laws of physics to the acquisition, transmission, and processing of information in order to generate new knowledge and technologies that will expand the U.S. industrial base, provide new employment opportunities, and bolster the economy and national security. STPI assisted the National Quantum Coordination Office in drafting a strategic implementation plan to support the National Strategic Overview for Quantum Information Science. STPI prepared memoranda for the Subcommittee on Economic and Security Implications of Quantum Science that summarized QIS research and development needs, assisted the National Quantum Coordination Office to host its second QIS Program Day, and provided extensive support for a report on QIS Frontiers.

Analysis of Chinese artificial intelligence funding

In 2017, the Chinese State Council issued a *New Generation Artificial Intelligence Development Plan* that instructed national ministries, provincial and municipal governments, and the private sector to invest in artificial intelligence (AI) R&D. However, China's AI R&D funding landscape is complex, composed of many actors, and has features not found in Western innovation ecosystems. OSTP asked STPI to explore the qualitative differences between U.S. and Chinese government expenditures on non-defense R&D for AI. To address this issue, STPI developed a heuristic to evaluate various means by which China funds AI R&D. STPI found that some types of Chinese R&D funding for AI are analogous to those in the United States, but some of the major Chinese funding mechanisms do not have a U.S. analog. Thus, comparisons of top line government spending on AI R&D between China and the U.S. are not an apples-to-apples comparison. STPI delivered these findings to OSTP in the form of a methodology report and a final public report.

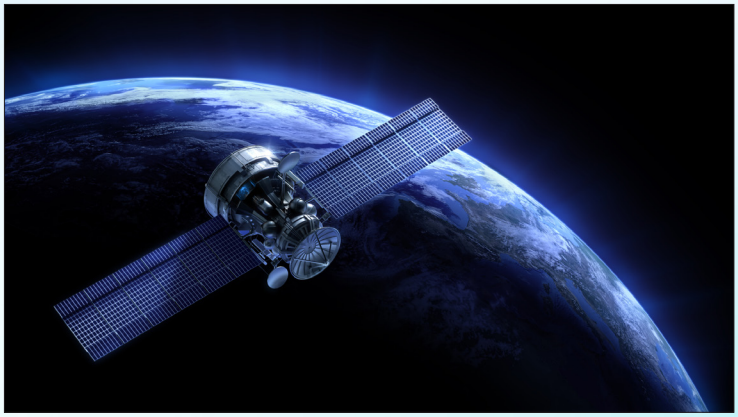
Automated vehicles

Automated vehicles (AV) use a combination of sensors, cameras, radar, and AI to travel between destinations without a human operator. They are predicted to enhance the safety and mobility of the American public, expand the American economy, and improve global competitiveness. OSTP asked STPI to provide assistance in understanding the status of surface AV R&D and the role of the Federal Government in its development. STPI developed a draft request to agencies for information regarding their roles, responsibilities, and activities for AV R&D; organized the information; and supported drafting the report entitled, *Ensuring American Leadership in Automated Vehicle Technologies*. The report contains an overview of Federal AV policy; legal, outreach, and research activities; and 10 principles to guide and unify Federal approaches to advance AV R&D.

Civilian supersonic aircraft

The development of civilian commercial supersonic flight is challenged by technological, economic, and policy considerations. OSTP asked STPI to assess the potential future of civilian supersonic aircraft, offering options that the Federal Government may use, as appropriate, to support supersonic transport. STPI conducted interviews with company representatives, government officials, and aerospace experts to determine the state of the art in industry and challenges impeding supersonic aircraft development and deployment. STPI also considered policies regarding noise pollution; the current ban on speeds greater than Mach 1; and U.S. cooperation with international regulations. In a briefing and report to OSTP, STPI outlined the challenges to commercial viability of supersonic flight and recommended a regulatory analysis that would include landing and takeoff noise regulations specific to supersonic aircraft and the implementation of Mach cut-off flight.

SPACE TECHNOLOGY AND POLICY



Space weather

In 2018, the Space Weather Operations, Research, and Mitigation (SWORM) Subcommittee of the NSTC released the Space Weather Phase 1 Benchmarks, which specify the nature and intensity of extreme space-weather events and provide a point of reference from which to improve understanding of their effects. The National Science Foundation (NSF) and NASA asked STPI to carry out a project focusing on taking the next steps to improve the benchmarks. STPI drafted and released a request for community input on extreme space weather R&D gaps, assembled a panel of the world's leading space weather experts, and organized a 3-day workshop and a 2-day town hall event. The panel identified significant gaps in the methodologies of the Phase 1 benchmarks, proposed new methodologies and benchmark values, and highlighted new areas of research and observational capabilities needed to understand extreme space weather. The resulting report is being used to inform further actions in the National Space Weather Strategy and Action plan.

In 2019, OSTP asked for STPI's assistance to update the Nation's strategy for space weather resilience. Specifically, STPI worked with OSTP, the SWORM Subcommittee, and other stakeholders to design and write the goals, objectives, and high-level actions of U.S. National space weather strategy. Following publication of the National Space Weather Strategy and Action Plan, OSTP asked STPI to assist in the development of an implementation roadmap that specifies concrete actions, deliverables, timelines, and leadership to implement the strategy. STPI participated in an NSF/NASA project to identify the next steps to space weather benchmarks—the first action called for in the strategy—and drafted the results of an expert panel and other stakeholder events into recommendations that refine the benchmarks. STPI coordinated with 14 working groups to help them define their actions and timelines in support of the national strategy within the framework of a national implementation plan that identifies responsible agencies and sets timelines for implementing the National Space Weather Strategy and Action Plan.

Orbital debris

In April 2020, the Federal Communications Commission (FCC) proposed updated rules for mitigating orbital debris, which generated controversy in the commercial satellite industry. The National Space Council (NSpC) asked STPI to rapidly and independently assess the proposed rules to determine whether they were technically supportable and whether they could harm the competitiveness of U.S. space companies. STPI conducted targeted interviews, performed a literature review (including evaluating all of the ex parte comments submitted to the FCC), and then developed and applied a heuristic for assessing the technical soundness of the proposed rules.

Sustainable Moon presence

Presidential Memorandum Space Policy Directive 1 (SPD-1) initiated a U.S.-led program for a human return to the Moon. Activities on the Moon would involve the

conduct of science, including astronomy and geology; exploration, in that the Moon is a test bed for Mars; and commercial activities. The program would require a whole-of-government effort. OSTP asked STPI to identify which Federal agencies could be involved in establishing a long-term sustainable presence on the Moon, what their role might be, and whether there will be a need for future interagency coordination. STPI systematically examined the missions, activities, and statutes of Federal agencies; reviewed publicly available literature and asked experts on lunar development to determine the factors required for a long-term sustainable presence at the Moon's South Pole; and assessed the possible need for interagency coordination. Considering a field station at the lunar South Pole, STPI examined the role of the U.S. Government in promoting private sector commercial activity as well as science and exploration—and identified civil agencies other than NASA that have expertise, resources, or authority that could contribute to or benefit from U.S. plans for Moon development. STPI identified 47 cabinet-level departments, high-level intra-departmental agencies and offices, and independent agencies as having the potential to play a role in a sustained U.S. lunar presence at some point in the program's development.

Moon to Mars analysis

In 2019, NSpC recommended the creation of a "Moon to Mars Development Plan" to coordinate the whole-of-government effort required to maximize the benefits derived from America's space efforts. NSpC asked STPI to utilize its expertise in Federal and commercial space to engage stakeholders from government agencies and the private sector regarding needs, goals, and roles to develop a plan. STPI also evaluated previous national plans for major space programs.

Microgravity

NASA has been the primary entity conducting microgravity R&D for decades, but with the growth of commercial space companies, falling costs in some R&D fields, and the planned upcoming transition from the International Space Station (ISS) to commercial space stations in low Earth orbit, many aspects of the microgravity R&D enterprise are changing. OSTP asked STPI to assess the microgravity R&D landscape to recommend future R&D priorities, identify barriers to conducting R&D, and suggest policy solutions to overcome those barriers. STPI conducted interviews with stakeholders in many scientific fields as well as commercial facility operators and ISS management. STPI's report will inform the activities of a National Science and Technology Research Council that will coordinate the efforts of multiple agencies working in the microgravity R&D enterprise.

In concert with OSTP's assessment of the microgravity R&D enterprise, NSpC asked STPI to draft elements of a National Microgravity R&D Strategy. STPI is leveraging the proceedings from NSpC's Microgravity Roundtable in October 2020 to examine the response across the whole-of-government needed to streamline the enterprise and maximize the Nation's investment in microgravity R&D. STPI delivered a list of goals,

objectives, and potential actions that will inform NSpC's policy considerations as it works toward developing a national strategy and guiding a potential working group that would focus on high-level national efforts in microgravity R&D.

Position, navigation, and timing services

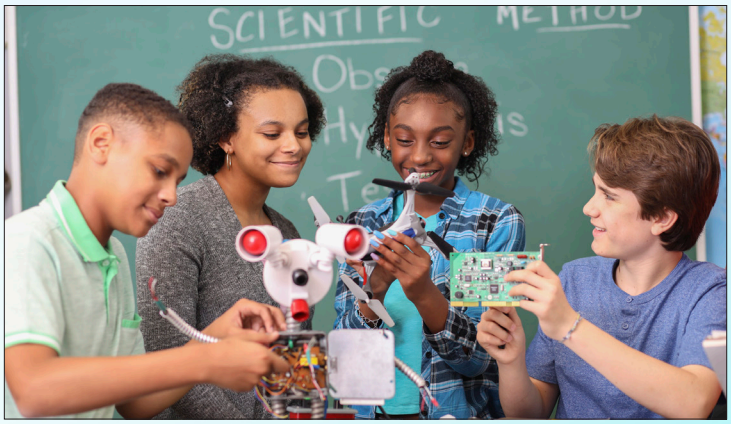
The Global Positioning System (GPS) provides users worldwide with positioning, navigation, and timing (PNT) services. Positioning refers to location and orientation; navigation to current and desired position; and timing to precise time according to a standard, such as Coordinated Universal Time. As the number of devices and users relying on GPS has grown to tens of billions, OSTP and the NSC, through an interagency group, evaluated policy and implementation issues associated with PNT services and critical infrastructure sectors. STPI supported OSTP actions to explore approaches that enhance the security, reliability, resilience, and robustness of critical infrastructure systems to disruption in PNT signals and services. In that role, STPI performed a comprehensive search for existing policies related to PNT, and facilitated discussions to identify PNT policy gaps and to develop policy options and recommendations. STPI also assessed NIST's Cybersecurity Framework for its utility in promoting risk-informed use of PNT services across public and private critical infrastructures. STPI's work informed the development of Executive Order 13905, *Strengthening National Resilience Through Responsible Use of Positioning, Navigation, and Timing Services,* issued in February 2020. The Executive Order called for a national plan to conduct R&D and pilot testing of additional, robust, and secure PNT services as well as integrate and use multiple PNT services to enhance the resilience of critical infrastructure. STPI is supporting and contributing intellectually to the interagency working group that is tasked with developing this R&D plan.

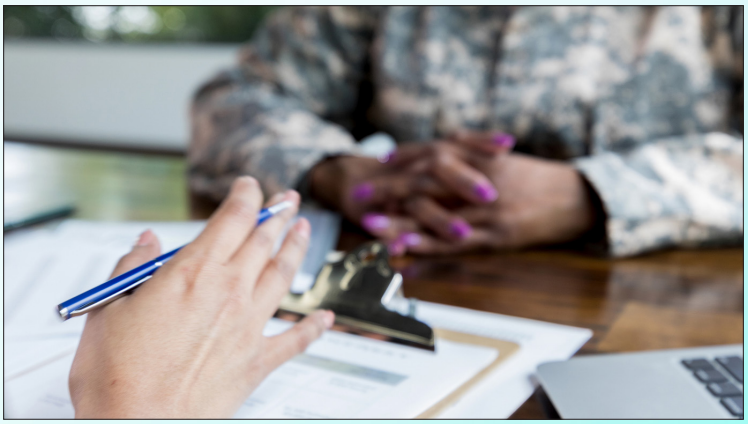
In a second PNT project, STPI provided technical and logistical support to an NSpC interagency working group charged with updating the National Security Presidential Directive-39, the national policy governing U.S. space-based PNT systems. STPI facilitated roundtable discussions between government representatives and participated in drafting policy updates on complementary PNT systems; PNT for space systems, cybersecurity, and critical infrastructure; and new governance policy.

Satellite needs

OSTP, through the Satellite Needs Working Group of the NSTC's USGEO Subcommittee, supports a biennial process to collect satellite measurement needs from Federal civil agencies. The objective of this process is to identify, collect, and transmit civil agency measurement requests to NASA for consideration in its systems engineering process. In 2020, STPI supported briefings of the technical and policy analyses of the recently completed second survey cycle and contributed to the development and launch of the third satellite needs data collection process and implementation of the survey.

STEM EDUCATION, WORKFORCE, AND TALENT POOL





STEM workforce development

Building a diverse, highly-skilled STEM workforce is central to maintaining the United States' global leadership in science and technology. OSTP requested that STPI research and summarize information about barriers to STEM education and careers faced by underrepresented and underserved communities, particularly women and girls, veterans, historically underrepresented minorities, and rural Americans. As part of the requested work, STPI identified and summarized approximately 50 Federal and non-Federal programs that seek to increase underrepresented and underserved group participation in STEM. STPI's findings will inform STEM initiatives at OSTP.

STEM education

The America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (COMPETES) Reauthorization Act of 2010 tasks OSTP with the coordination of Federal STEM education programs. It requires the Director of OSTP to deliver to Congress an annual report on STEM education programs and activities and their funding levels, an evaluation of their degree of duplication and fragmentation, a description of progress made in carrying out a previously created implementation plan, and a description of how the participating Federal agencies disseminate information about federally supported resources for STEM education practitioners. OSTP asked STPI to assist in supporting the activities of the Federal Coordination in STEM Education Subcommittee (FC-STEM), including development of the initial implementation plan based on the 2018 STEM education 5-year strategic plan, technical analyses, and other support to complete the annual STEM education progress report, maintenance of the STEM Guiding Principles, as well as other activities of the Subcommittee. In 2020, STPI contributed analysis of data for use in the 2020 STEM progress report and the Inventory of Federal STEM Investments, using the benchmarks established in the 2018 strategic plan.

Veterans in STEM careers

The Supporting Veterans in STEM Careers Act (signed in February 2020) aims to promote the involvement and equity of veterans and military spouses in the STEM workforce. The law tasks OSTP to establish an interagency working group, develop a strategic plan to identify the barriers to reentry faced by veterans and their spouses, and outline activities Federal agencies can pursue to address these barriers. OSTP called upon STPI for support in developing a strategic plan for advancing veterans and military spouses in STEM careers. In addition to providing planning and development support, STPI conducted literature research and informational interviews with Federal and non-Federal stakeholders to understand the barriers facing veterans and military spouses as they transition into or try to retain STEM careers and to gain insight into the programs currently aimed at removing these barriers. STPI's research has been used to inform briefings given by OSTP to policy makers and as part of the background materials provided to a newly forming interagency working group on veterans and military spouses in STEM. In addition, STPI's work will provide background information for the strategic plan.

Veteran suicide prevention

Military veterans accounted for approximately 22 percent of the nearly 45,000 U.S. suicide deaths in 2016. Given the complexity of factors contributing to a decision to commit suicide and the limitations in current data sources on the causes and prevention of suicide, OSTP asked STPI in 2018 to evaluate ongoing activities, relevant entities, and Federal efforts to advance veteran suicide prevention research. In 2019, OSTP requested STPI's assistance to develop a national research strategy on veterans' suicide prevention. STPI analyzed responses to an RFI on the National Research Strategy for the President's Roadmap to Empower Veterans and End Suicide (PREVENTS); facilitated discussions at the White House Summit on PREVENTS; and coordinated five interagency writing teams that developed the National Research Strategy focusing on risk identification, prevention intervention, research translation, data sharing, and data integration. The strategy prioritizes suicide prevention research and promotes changes to the research ecosystem; it was released as part of the PREVENTS Roadmap in 2020 and will be used by agencies to guide veteran suicide prevention and research efforts.

STEM data inventory and Federal data sharing

In 2018, the President issued an Executive order establishing the President's National Council for the American Worker. The Council and its Advisory Board established data working groups to identify the best use of existing data and tools to support informed decision making by American students and workers. In support of this effort, using data compiled by Federal agencies and non-Federal statistical groups, STPI compiled a data inventory of Federal resources relevant to STEM workforce and education, submitted to OSTP in 2019. The effort to build a STEM data inventory led OSTP to ask STPI to carry out a wider range of analyses related to advancing data sharing efforts across the Federal Government. In October 2019, OSTP asked STPI to provide background materials spanning the legal and technical landscape around data sharing for a White House Roundtable on Accelerating the Responsible Sharing of Federal Data. STPI reviewed literature and conducted interviews with Federal statistical agency employees to produce a document with a review of the key legislation that governs collection, privacy, and sharing of Federal data; an overview of technical methods to increase privacy protections; and select initiatives that highlight current data sharing efforts.

INFRASTRUCTURE ASSESSMENTS

Electromagnetic pulse hazards

Electromagnetic pulses (EMPs) can potentially damage or disrupt critical components of the Nation's electrical infrastructure and cause a grid security emergency. Executive Order 13865, *Coordinating National Resilience to Electromagnetic Pulses*, gives OSTP an important role in coordinating executive branch actions to assess, prioritize, and manage the risks of EMPs. STPI supported the creation of an interagency working group led by OSTP and composed of agencies that have EMP R&D responsibilities. With STPI's assistance, the IWG identified R&D gaps that, if addressed, would improve the Nation's resilience to the effects of an EMP. STPI then helped to develop the framework for and drafts of a Federal R&D plan for improving the Nation's preparedness to the effects of an EMP, resulting in an NSTC document entitled *Research and Development Needs for Improving Resilience to Electromagnetic Pulses* that will be used to guide future government expenditures on EMP R&D related to resilience.

Contaminants of emerging concern

Contaminants of emerging concern (CECs) are newly identified or re-emerging manufactured or naturally occurring physical, chemical, biological, radiological, or nuclear materials that may cause adverse effects to human health or the environment and do not have a national primary drinking water regulation. In the December 2019 National Defense Authorization Act, Congress directed OSTP to develop a National Emerging Contaminants Research Initiative that would guide a CEC Interagency Working Group in coordinating Federal research programs operating in this arena. OSTP asked STPI's assistance to launch the working group, assist in drafting the research initiative, develop a CEC public engagement event, and participate in the IWG leadership team. The working group was launched in April 2020, and its five technical teams were stood up in July. STPI assisted the working group and technical teams to identify CEC research gaps and needs and to develop cross-cutting research areas.

Post-earthquake re-occupancy and functional recovery time

NIST requested STPI to assist it and the Federal Emergency Management Agency (FEMA) in drafting a congressionally mandated report outlining options to enable re-occupancy and recovery of the function of the built environment after earthquakes. The intent of current building codes for most buildings is to safeguard against loss of life to building occupants by minimizing the probability of structural collapse during earthquakes. Preserving building functionality after an earthquake is not the primary consideration in current codes for most classes of buildings. Widespread building damage, and degradation or loss of building functions, can have severe social and economic impacts on a community. To reduce the likelihood and severity of potential property damage and enable more rapid recovery from earthquakes, Congress tasked NIST and FEMA to convene a Committee of Experts to develop options for improving the built environment and critical infrastructure.

NIST tasked STPI to perform two main activities:

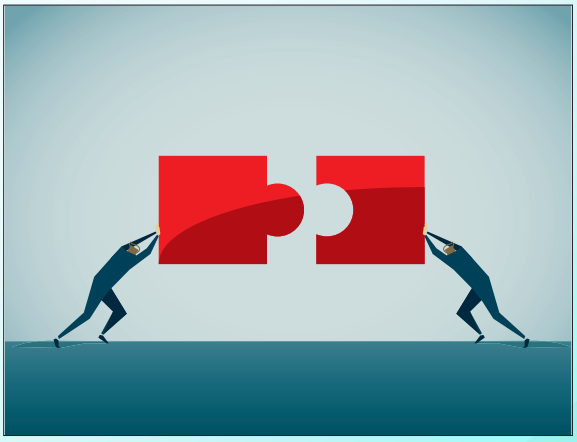
1. Organize meetings of the project review panel (PRP), part of the Committee of Experts, that worked to develop a set of options and recommendations for Congress concerning functional recovery after earthquakes. STPI suggested relevant experts to serve as PRP members and facilitated meetings of the group, which convened on three occasions to review drafts of the report to Congress and provide feedback.

2. Convene and facilitate five stakeholder workshops, held at multiple locations around the country, to provide additional input to the report to Congress. In the course of the workshops, participants categorized components of the built environment for community stability over specific timescales, and identified evaluation criteria policy makers could use to assess and compare options to improve functional recovery. The STPI team distilled the workshop findings and shared the information with NIST to help inform the report to Congress.

Resilience programs

In order to strengthen community resilience across the United States, NIST is developing data, software, and tools to support resilience planning and recovery after disruptive hazard events. To improve quality, increase value, and better align NIST products with other Federal agency requirements and products, NIST asked STPI to characterize the resilience-related requirements that communities need to meet when working with Federal agencies. Specifically, NIST asked STPI to characterize existing community resilience programs and requirements within Federal agencies; analyze the current state of software, tools, and data available to meet these requirements; identify unmet needs; and develop recommendations for future software, tool, and data provisions. STPI built two databases based on publicly available information and interviews conducted with Federal resilience program managers, one cataloguing Federal programs that advance one or more aspects of community resilience and the other cataloguing Federal, academic, commercial, and non-profit tools that communities can use to enhance their resilience. By analyzing and visualizing the data in both compilations, STPI determined that Federal resilience programs vary greatly in their requirements and that the vast majority of resilience tools available to communities do not directly address the specific requirements posted by Federal programs.

ADVANCING FEDERAL R&D PARTNERSHIPS



Partnership mechanisms

Partnerships across multiple sectors—government, industry, non-profits, and academia—are critical to advance the United States' R&D endeavor in an increasingly competitive world. Because partnerships cut across almost every issue touched by OSTP, STPI was asked to identify the entire gamut of Federal partnership mechanisms and provide insights on the legal and regulatory frameworks governing their implementation. In response to this request, STPI developed a matrix of partnership mechanisms and how they enabled the exchange of different resources between partners. The resulting compilation has served as a reference for the Federal community of partnership practitioners.

Partnership intermediary agreements

Partnership Intermediary Agreements (PIAs) are used by the Federal Government to increase the likelihood of success in conducting cooperative or joint activities with institutions of higher education and commercial firms to facilitate technology transfer by making use of a non-profit partnership intermediary. The Department of Defense (DOD), which is a major driver in the growth of PIAs across the Federal Government, asked STPI to analyze their use of PIAs and identify best practices in their establishment and implementation. STPI reviewed relevant published literature and program documents as well as conducted interviews and questionnaires with stakeholders. STPI found that PIAs are useful for enabling traditional spin-out as well as dual-use and spin-in technology transfer activities, although policy clarifications are needed regarding the bounds of functions and funding mechanisms under PIAs and to ensure that PIAs are used effectively and efficiently.

Technology commercialization evaluation

In 2012, the Department of Energy (DOE) established the Agreements for Commercializing Technology (ACT) Pilot to appraise a new mechanism for removing barriers for businesses and startups interested in working with DOE Laboratories. Specifically, the ACT attempts to address certain terms and conditions—considered by some stakeholders to be shortcomings—found in traditional agreements. STPI was asked by DOE's Office of Technology Transitions to conduct an evaluation of the ACT contracting mechanism aimed at developing a quantitative and qualitative assessment of ACT and the FedACT Pilot (an expansion of ACT to include federally funded partners) to determine early outcomes, lessons learned, and best practices as well as informing DOE's response to a report required by Congress in the 2018 Department of Energy Research and Innovation Act (Public Law 115-246, section 107). STPI researchers interviewed 29 representatives from 16 National Laboratories, and 7 representatives from offices at DOE headquarters. STPI also analyzed quantitative data related to laboratory technology transfer, ACT, and FedACT as well as other contracting mechanisms, such as Cooperative Research and Development Agreements (CRADAs) and Strategic Partnership Projects (SPPs). STPI found that ACT and

FedACT pilot agreements facilitate collaborations when a potential partner needs greater flexibility than what traditional agreements (SPPs or CRADAs) offer. Flexibility to negotiate non-standard terms was considered especially useful in agreements with non-profits or State and local governments, which are usually required to use their own (rather than Federal) contracting templates as starting points. Laboratories see ACT and FedACT pilot agreements as complementing SPPs and CRADAs rather than as potential replacements for them.

Space patents

The NSpC staff asked STPI to provide background research on select topics related to commercial space intellectual property including commercial space company intellectual property strategies. STPI conducted targeted interviews with Federal officials within NASA and the United States Patent and Trademark Office as well as private sector industry organizations representing small and medium businesses in the space sector. STPI identified challenges derived from intellectual property policy in the space sector and provided recommendations for addressing barriers to patenting and improving the awareness and licensing of NASA-funded intellectual property, including developing more uniform policies, streamlining waiver processes, and strengthening NASA's technology transfer mechanisms. In addition, STPI recommended convening stakeholders on broader intellectual property regime issues and revising the intellectual property regime to allow for greater ownership by the private sector. The resulting report informed NSpC deliberations regarding challenges related to intellectual property in the commercial space sector.

FEDERAL PANDEMIC PREPARATION AND RESPONSE

Bioincident modeling

In response to global events that threatened the health security of the Nation, the NSTC Subcommittee on Biological Defense Research and Development underwent a reorganization to account for the varied interagency approaches to human, animal, and plant health security. OSTP asked STPI to assist in drafting a new NSTC Subcommittee framework that culminated with the creation of the NSTC Health Security Threats Subcommittee.

In addition to the wider challenge of pandemic health security, OSTP asked STPI to provide rapid response analyses in support of the OSTP Director's role on the White House COVID-19 Task Force. STPI's analytical products and activities supported several OSTP response efforts including the development of a document for tracking and updating COVID-related information on clinical trials and diagnostics test development, as well as supporting OSTP's role in launching the NASEM Standing Committee on Emerging Infectious Diseases and 21st Century Health Threats whose mission is to help inform the Federal Government on critical science and policy issues related to emerging infectious diseases and other 21st century health threats.

Federal COVID-19 data sharing

In April 2020, STPI support for OSTP on broader data sharing issues shifted to focus on COVID-19 data sharing efforts. In April 2020, STPI reported on current practices for collecting and sharing U.S. COVID-19 diagnostic data among Federal and State agencies, as well as non-governmental institutions in the early days of the pandemic. STPI's report described routine public health surveillance practices and Federal and State authorities for data collection and sharing and then considered how policies were changing in response to COVID-19. In July 2020, OSTP asked STPI to conduct an additional COVID-19 related analysis, this time a lessons-learned analysis of a new Federal data sharing initiative called the OSTP-supported COVID-19 Insights Partnership. STPI conducted interviews with key players of the COVID-19 Insights effort to understand what successes have been achieved, what barriers have been overcome, and how those barriers were resolved.

Space industry and COVID-19

The COVID-19 pandemic has had social and economic impacts on American life and commerce, including the U.S. space industry. NSpC staff asked STPI to review available economic policy instruments and programs and other government actions that could be used to support priority sectors of the U.S. space industry and recommend which are most worthy of consideration. STPI divided the industry into those companies that are primarily government contractors versus those focused on the private sector. To assess industry health, STPI looked at likely income sources for both categories: funding levels for government contractors and non-government financing for companies focused on the private sector. Government policies advocated

by the space industry were also assessed. STPI concluded that the government should accelerate contracts and contract payments and support companies that provide critical components for space national security systems.

Resilience science and technology

In May 2019, the NSTC's Committee on Homeland and National Security established an interagency subcommittee that focuses on strengthening and promoting national resilience against threats and hazards that could have catastrophic consequences to national essential functions. A primary purpose of this new group, the Subcommittee on Resilience Science and Technology (SRST), is to coordinate and improve Federal science and technology innovation and utilization through policy and practice. STPI provided dedicated analysis and support to OSTP in conceptualizing, planning, and completing a wide variety of SRST deliverables aimed at increasing national resilience through Federal science and technology coordination and innovation. In 2020, STPI developed an approach to assess protocols and after-action reports from both exercises and real world events to identify resilience science and technology gaps and spot opportunities to incorporate resilience science and technology into future events and incidents. STPI also designed an approach to develop resilience science and technology that aligns with societal dimensions and critical functions. In response to COVID-19, STPI developed a framework for identifying non-medical countermeasures designed to be expandable to other hazard events, resulting in a co-authored report entitled *Non-Medical Interventions: A Desk Reference to Help Planners Recover from COVID-19 and Prepare for Future Outbreaks and Pandemics* published by the DHS Science and Technology Directorate and pushed out to their emergency communications and first response organizations. These and other products are being used by the SRST in support of their current activities.

AGENCY PROGRAM AND PORTFOLIO ASSESSMENTS

National Institutes of Health (NIH) Director's Early Independence Award

The NIH Director's Early Independence Award (EIA) initiative is a component of the NIH Common Fund's High-Risk, High-Reward Research program, which supports exceptionally creative, highly innovative scientists and research with the potential for broad impact in biomedical or behavioral science. The NIH Office of Strategic Coordination, which manages the Common Fund, asked STPI to assess the effectiveness of the EIA program in accelerating the entry of exceptional junior investigators into positions of independent research by omitting the traditional post-doctoral training period. To evaluate these awards, STPI used a multi-modal approach that included, as appropriate, comparison groups, participant surveys, expert reviews, and bibliometric analyses. The EIA final report was delivered to NIH in 2020.

Development of evaluation metrics for NIH's Office of Portfolio Analysis

The NIH Office of Portfolio Analysis (OPA) asked STPI to identify, where possible, risks and vulnerabilities that could prevent an NIH innovation from maturing within the NIH infrastructure and across the larger biomedical innovation ecosystem. STPI reviewed the literature on risk and innovation, conceptualized a biomedical innovation ecosystem, and identified those elements applicable to NIH. STPI then evaluated opportunities for NIH to de-risk its biomedical research pipeline in order to provide more innovative products to improve health, combat illness, and ease disability. In its report sent to OPA in March 2020, STPI determined that NIH has created interventions for most high-risk areas for biomedical innovation and identified data sharing partnerships as an opportunity to continue its de-risking efforts.

Analysis and recommendations on strategic management of the National Cancer Institute (NCI) National Clinical Trials Network

In June of 2005, the NCI Clinical Trials Working Group submitted to the National Cancer Advisory Board its report entitled *Restructuring the National Cancer Clinical Trials Enterprise*. An overarching recommendation implicit in many of the initiatives proposed in the report was the need for implementation of a more seamless, flexible and efficient, and collaborative NCI-funded clinical trial system that would be able to strategically harmonize NCI's entire clinical trial and clinical research network. Growing out of previous work STPI conducted in support of the National Clinical Trials Network, the Director of NCI's Coordinating Center for Clinical Trials requested that STPI provide strategic and analytical support for the NCI Clinical Trials and Translational Research Advisory Committee (CTAC) Strategic Planning Working Group convened to develop recommendations for realizing the vision for cancer clinical trials in 2030 and beyond as well as improving the operational efficiency and reducing the cost of cancer clinical trials today and in the future. STPI guided and

facilitated the deliberations of six subgroups formed to develop draft recommendations for the Working Group to consider; prepared discussion guides and summary notes for two conference calls of each of the subgroups; prepared materials for, facilitated, and developed summary notes for Working Group webinars; and drafted the final Report for NCI and Working Group approval. The Final Working Group Report, containing 16 recommendations and associated implementation actions, will inform the guidance of NCI clinical trials over the next decade.

Administration and analysis of the United States Antarctic Program logistics support data collection instrument

The NSF Polar Programs catalyze fundamental discovery and understanding of polar systems and their global interactions to inform the Nation and advance the welfare of all people. NSF asked STPI to develop a data collection instrument that would assist in evaluating the effectiveness of the NSF contract for logistical support for the United States Antarctic scientific research program. Following an extensive series of interviews with NSF program staff, contract staff, and research community members, as well as site visits to contract supply warehouses and research stations, STPI identified data elements that assess the delivery of logistical support for planned and unanticipated research and personnel needs, as well as specific contractor support functions. In 2020, STPI continued its annual task of collecting and analyzing the survey responses and presented the results to NSF. The STPI findings will assist NSF in improving logistics support services and supporting the Antarctic research projects.

Powering Agriculture: An Energy Grand Challenge for Development

Powering Agriculture: An Energy Grand Challenge for Development (PAEGC) is a partnership between the U.S. Agency for International Development (USAID), the Government of Sweden, the Government of Germany, Duke Energy Corporation, and the Overseas Private Investment Corporation. The goal of PAEGC is to support new and sustainable approaches to accelerate the development and deployment of clean energy solutions to increase agriculture production and value in developing countries. USAID asked STPI to conduct a final evaluation of the program by assessing the extent to which innovations were strengthened through the grant funding and technical assistance provided by PAEGC, and the extent to which the innovations increased the use or access to clean energy for increased agricultural productivity.

STPI designed a multi-modal, qualitative methodology that included progress reports and program metrics, site visits, and interviews. STPI evaluated 25 innovators and found that companies that received grants tended to be more successful than universities or non-profits and that innovators who lacked a coherent commercialization strategy did not perform well. STPI has delivered a methodology paper, a report containing detailed case studies and assessments of the entrepreneurs funded under Powering Agriculture, and a summative evaluation. Results of the study were presented to the donors and at a conference launching a new Grand Challenge—Water and Energy for Food—that is following on from Powering Agriculture. STPI's summative evaluation will provide USAID with information to design more effective selection and monitoring procedures for the Water and Energy for Food Grand Challenge.